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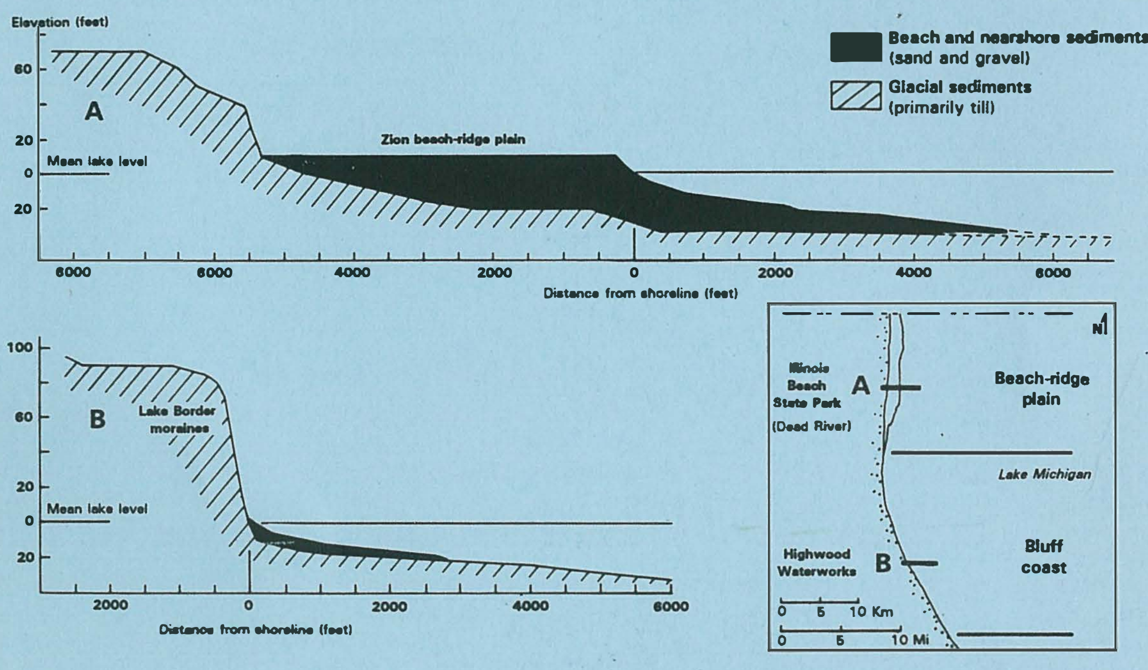
Great Lakes Shorelines: Unique Issues - Global Solutions
A Conference on Great Lakes Coastal Processes, Design, and Management

Pre-Meeting Field Trip

THE ILLINOIS COAST OF LAKE MICHIGAN: NORTH POINT MARINA TO EVANSTON'S DAWES PARK



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Field trip assistance provided by:
Illinois - Indiana Sea Grant and Illinois Department of Natural Resources

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THE ILLINOIS COAST OF LAKE MICHIGAN: NORTH POINT MARINA TO EVANSTON'S DAWES PARK
Sunday, October 13, 1996

OVERVIEW

This one-day field trip will have four stops along the northern half of the Illinois coast of Lake Michigan (fig. 1). Each stop illustrates some of the unique problems and challenges in the management and engineering of this coast. Each stop will also provide an opportunity to examine and discuss the local coastal geology and its relationship to local coastal management issues. The field trip will progress from north to south following the direction of net littoral drift. The four stops are:

Stop 1) North Point Marina Location / near Wisconsin-Illinois state line **(Page 11)**
This 1500-slip marina, largest in the Great Lakes, has been associated with major beach and lake-bottom changes since it was constructed in 1987-1988. The site visit will focus on the south (downdrift) side of the marina where erosion, beach nourishment, and plans for shore-defense structures are all ongoing issues.

Stop 2) Sunrise Park Beach Location / Village of Lake Bluff **(Page 19)**
The engineering of this beach park provides an example of the type of recreational and shore-defense facility that can be constructed along a sand-starved bluff coast.

Stop 3) Forest Park Beach Location / City of Lake Forest **(Page 29)**
Eight years of post-construction coastal monitoring have now been completed at this 22-acre beach park. The site visit provides an opportunity to examine the unique design of the facility and to discuss findings from the coastal monitoring program.

Stop 4) Dawes Park Location / City of Evanston **(Page 35)**
The City of Evanston is considering options for improving the recreational opportunities and aesthetics of its lakefront parks. This visit to Dawes Park provides an opportunity to examine several of the coastal management issues facing the City of Evanston.

ACKNOWLEDGMENTS

For their cooperation and assistance with logistics for the site visits, the field trip leaders wish to extend their appreciation to the following persons: Jim LaBelle, General Manager, North Point Marina; Max L. Slankard, Jr., Assistant to the City Manager, City of Lake Forest; Stefanie Schramm, Department of Earth Science, Northeastern Illinois University; and Phyllis Hartford, Illinois Department of Natural Resources, Office of Water Resources.

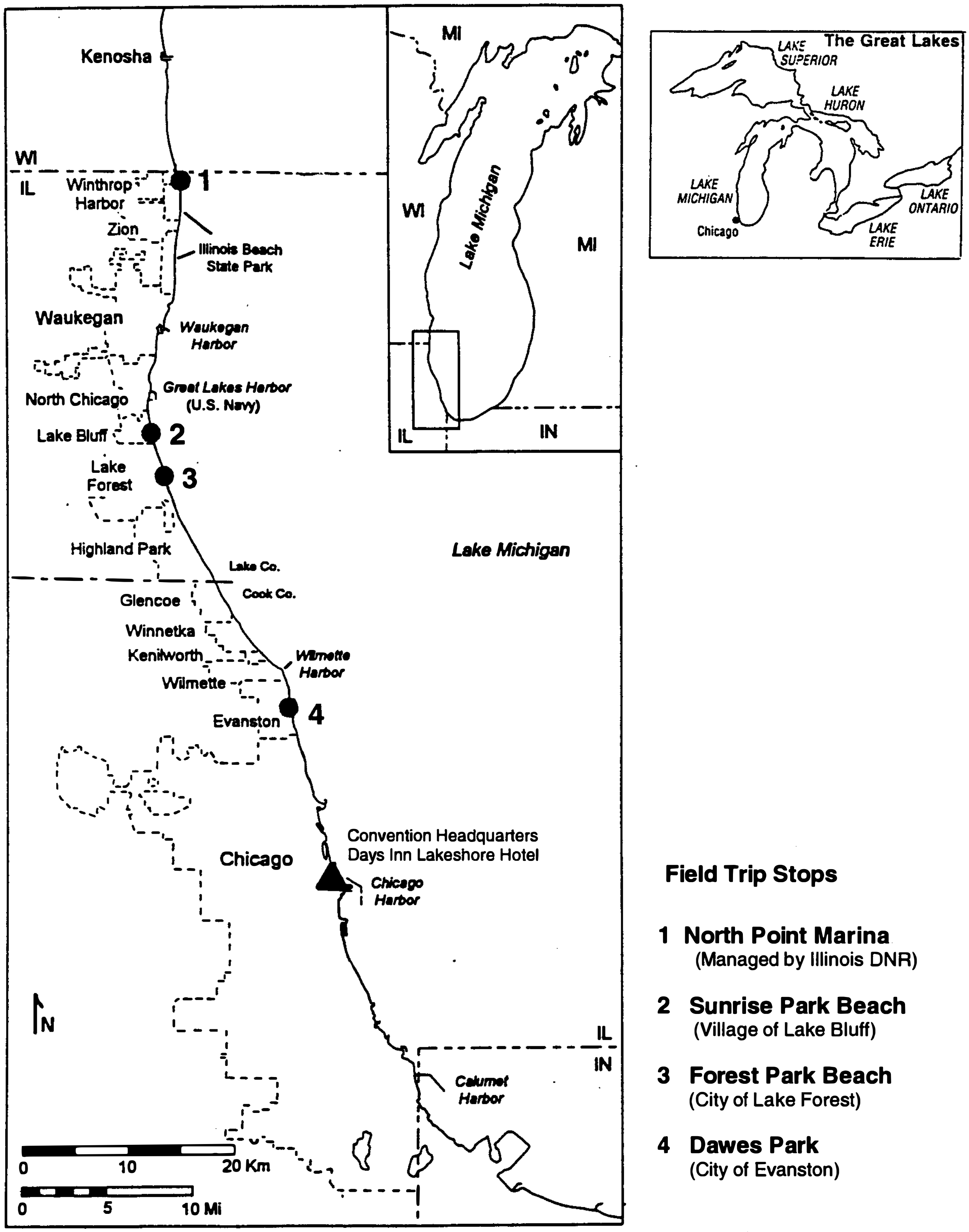

Figure 1. Location of field trip stops and names of municipalities along the Illinois shore of Lake Michigan.

COASTAL GEOLOGIC FRAMEWORK

Regional Coastal Setting and Geology

The Illinois coast of Lake Michigan extends 61 miles along the southern most reach of the western shore of Lake Michigan (fig. 1). This is the most populated coastal reach in the Great Lakes Region, and includes some of the region's most engineered shoreline. However, some "natural state" shoreline, dunes, and coastal wetlands still remain along the northern reach of the Illinois coast at Illinois Beach State Park (fig. 1).

The glacial history of the Illinois coast is reflected in the coastal geomorphology, sedimentology, and stratigraphy. Other than the modern beach and nearshore deposits, the coast is dominated by glacial till, glacial lake deposits, and glacial outwash. Bedrock, consisting of Silurian dolomite, crops out in the nearshore in a few localized areas.

The Illinois coast is divisible into three distinct, coastal-geomorphic settings (fig. 2):

<u>Zion beach-ridge plain:</u>

Along the northern 12 miles of coast is the Zion beach-ridge plain. This sand plain, which is at most about 12 feet (ft) above lake level, originates along the southern Wisconsin coast at Kenosha and extends southward to North Chicago. The plain is up to 1 mile wide and is a lens-shaped deposit of silt, sand, and gravel. In east-west cross section the plain is as much as 25 to 30 ft thick along the present coast and thins both landward and lakeward (fig. 3). The surface of the plain consists of curvilinear beach ridges and inter-ridge swales. These features record the progressive southward advance of the plain resulting from net southerly littoral transport (fig. 4).

<u>Lake Border Moraines bluff coast:</u>

From North Chicago and extending 15.5 miles to Wilmette, the modern coast intercepts moraines of the Lake Border Morainic System. These moraines are part of the series of recessional moraines related to retreat of the Lake Michigan ice lobe from the southern part of the Lake Michigan basin about 14,000 years ago. Some variance occurs in bluff height above mean lake level, but typically the maximum height is in the range 70 to 90 ft. The bluff slopes range from 25 degrees to near vertical.

<u>Chicago/Calumet lake plain:</u>

South from Wilmette 33 miles to the Illinois-Indiana state line, and continuing around the Indiana coast, the lakeshore is along a broad, relict lake plain. This is a glacially formed plain that was submerged by ancestral Lake Michigan when lake levels were higher than present during the past 14,000 radiocarbon years. Most of the City of Chicago occupies this plain. Parts of the present plain near the Illinois-Indiana state line were submerged as recently as about 1500 years ago. Along the eastern Indiana coast the plain is superimposed by dune fields that rise more than 100 ft above lake level (fig. 2).

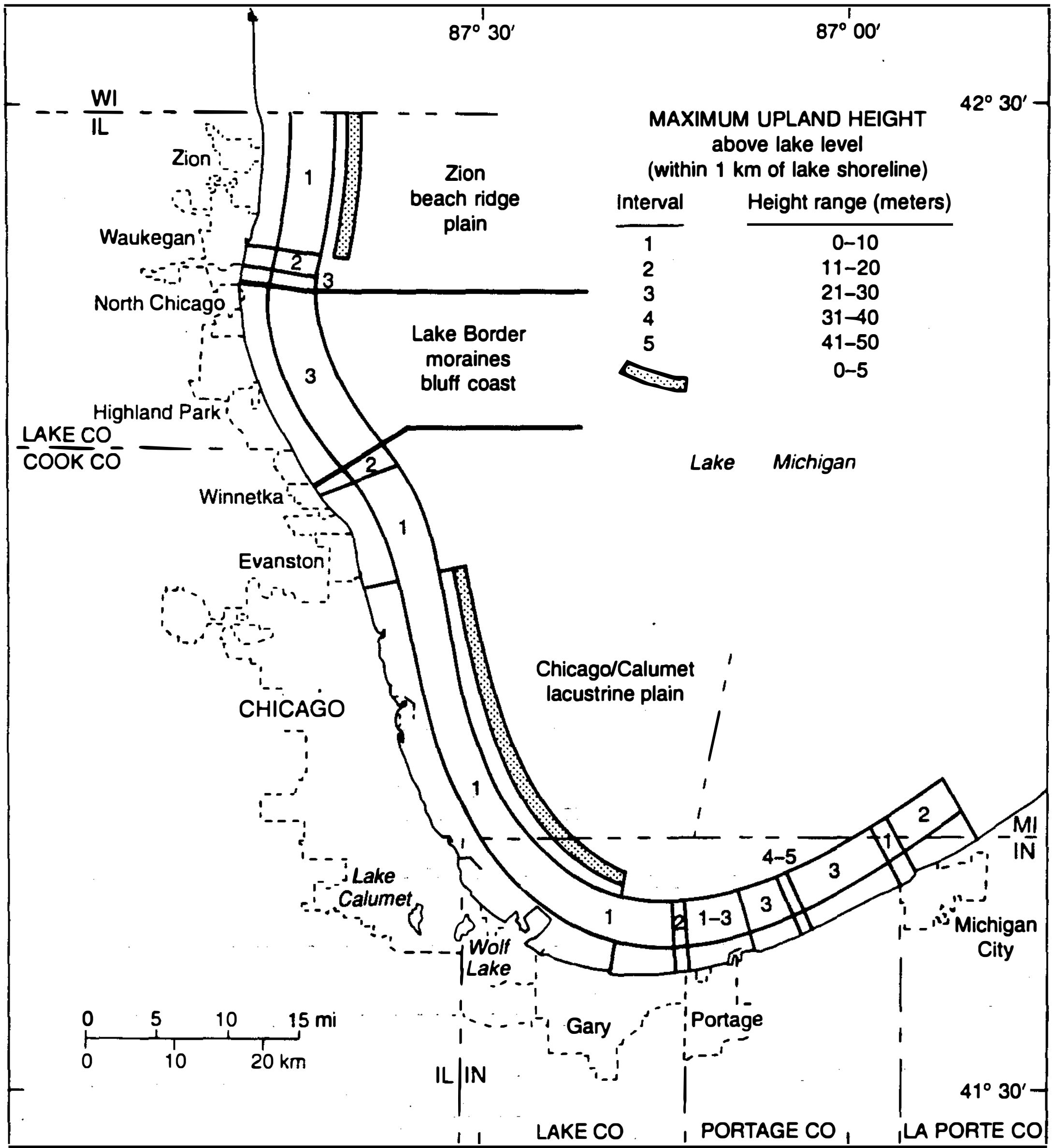

Figure 2. Division of the three coastal geomorphic settings along the Illinois-Indiana coast and the division of upland relief within one kilometer (0.6 mile) of the shoreline . The Illinois bluff coast has elevations in the range 69 to 98 ft above lake level. About half of the Illinois coast is no more than 16 ft above lake level (shown in the stippled band) (from Chrzastowski *et al.* 1994).

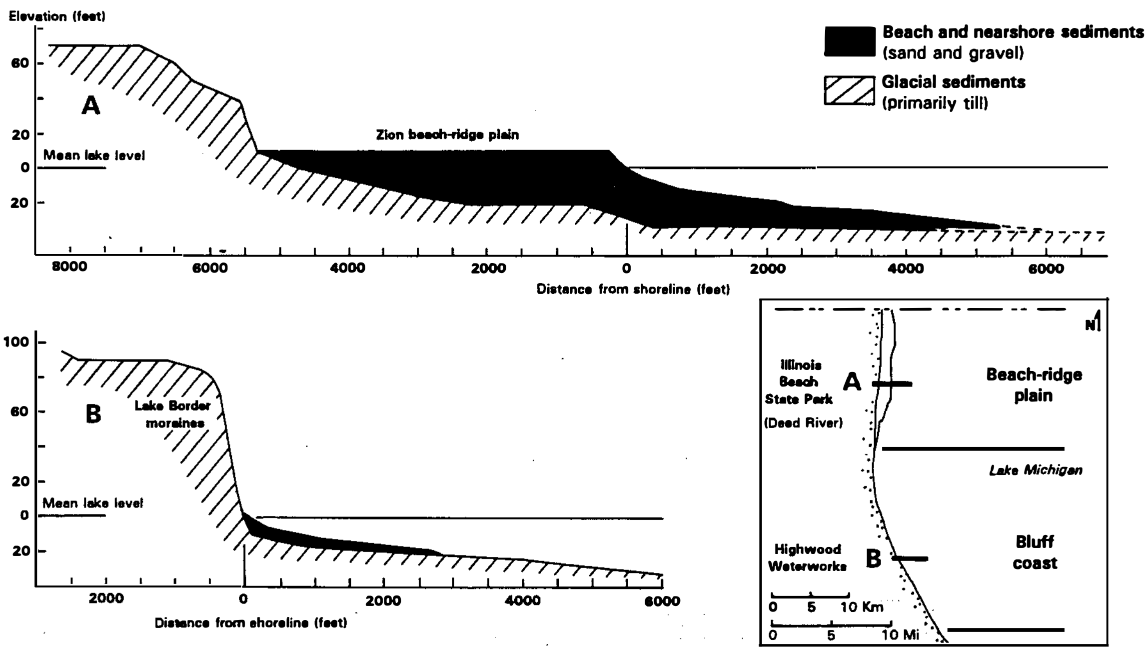

Figure 3. Cross sections along the northern Illinois coast comparing the thickness of beach and nearshore sand overlying the glacial till. Cross section "A" is a typical section at the Zion beach-ridge plain; cross section "B" is a typical section along the bluff coast. The thickest sand along the Illinois coast occurs at the Zion beach-ridge plain (from Chrzastowski and Trask 1995).

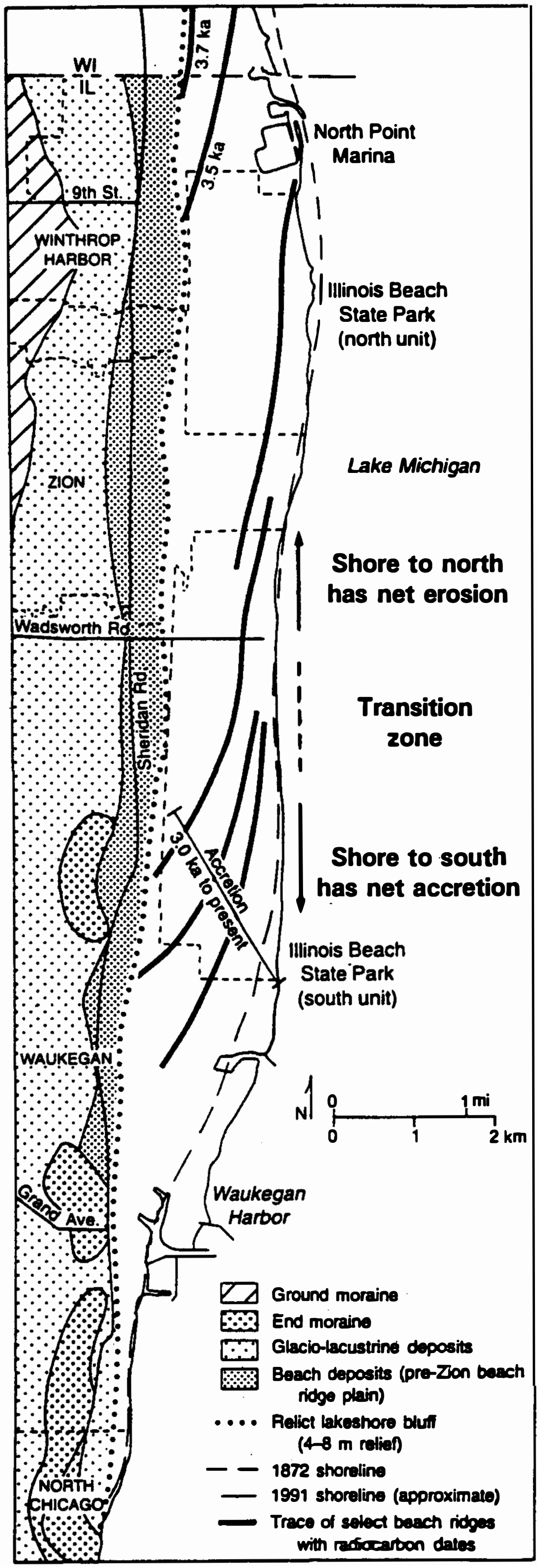

Figure 4. The Zion beach-ridge plain is a migratory coastal feature moving southward by net littoral transport. Arcuate beach ridges record relict shoreline positions. Erosion on the north and accretion on the south has resulted in the plain migrating southward along the coast similar to a tank tread. The plain first came southward across the Wisconsin-Illinois state line about 3,700 radiocarbon years ago. At present, the transition zone between net erosion and net accretion occurs in the South Unit of Illinois Beach State Park (from Chrzastowski and Trask 1995).

Lake Level Dynamics

Over the past 14,000 years, wide fluctuations in lake level have occurred in the southern Lake Michigan basin (fig. 5A). The extreme fluctuations occurred in the late glacial and early post-glacial history when movement of ice margins caused varied responses such as the opening and closing of lake outlets at different elevations, isostatic rebound of outlets, or the erosion and downcutting of the threshold elevation of different outlets. About 14,000 years ago lake level was about 60 ft higher than present, and at that time most of what is now the City of Chicago was submerged. About 10,000 years ago lake level was as much as 262 ft lower than present, and at that time most of what is now southern Lake Michigan was exposed lake bottom.

Historical records of lake-level changes date from 1860. During this 136-year record, mean monthly lake level has varied 6.3 ft between the historic low water in March 1964 and the historic high water in October 1986 (fig. 5B). The lake has an annual water-level fluctuation of about one foot with high water occurring in summer and low water in winter. As of summer 1996, lake level was as much as 0.8 ft above the long-term summer average (fig. 5B).

Coastal Processes

Wave Dynamics: Wave data along the nearshore of the Illinois coast indicate that for any given year, average wave height is 1.5 to 2 ft, average maximum wave height is 8 ft, and individual waves rarely exceed 10 to 12 ft. Average wave period is 4 seconds. The strongest and most frequent storm waves occur in late fall and early spring (U.S. Army Corps of Engineers 1953).

Littoral Sediment Transport and Supply: The source of sand and gravel for the beaches along the Illinois coast has been the erosion of coastal bluffs. The dominance of silt and clay in the till bluffs has meant that only about 10 to 15 percent of any eroded bluff sediment is suitable for residence along the beaches and nearshore (Lineback 1974). Net littoral sediment transport direction is southward in response to the fetch along the long axis of Lake Michigan and the net influence of waves from the northeast quadrant.

Prior to human modifications along the coast, a single littoral cell existed from the central Wisconsin coast southward to a terminus along the Indiana coast, and the Illinois coast was part of the transport pathway. Coastal structures have now segmented all of the southern Lake Michigan coast into a series of primary and secondary littoral cells. This field trip is along the central part of a primary cell that originates at Kenosha, Wisconsin and extends south to the Montrose peninsula on Chicago's north lakeshore (fig. 6). Figure 7 shows the updrift entrapment that has taken place at Waukegan Harbor. At present, sediment dredged from the harbor entrance is dumped in a near shore disposal site about one mile downdrift (south) of the harbor, thus creating an artificial bypass.

Littoral Sediment Volumes: The volume of littoral sediment in transport along the Illinois coast has been diminishing over time as more bluffs are defended from erosion, and as more barriers to littoral transport have been constructed. Based on comparisons of historical profile data, in the early half of the 20th century the littoral transport rate was 90,000 cubic yards/year along the coast at the Zion beach-ridge plain, and 57,000 cubic yards/year along the bluff coast (U.S. Army Corps of Engineers 1953).

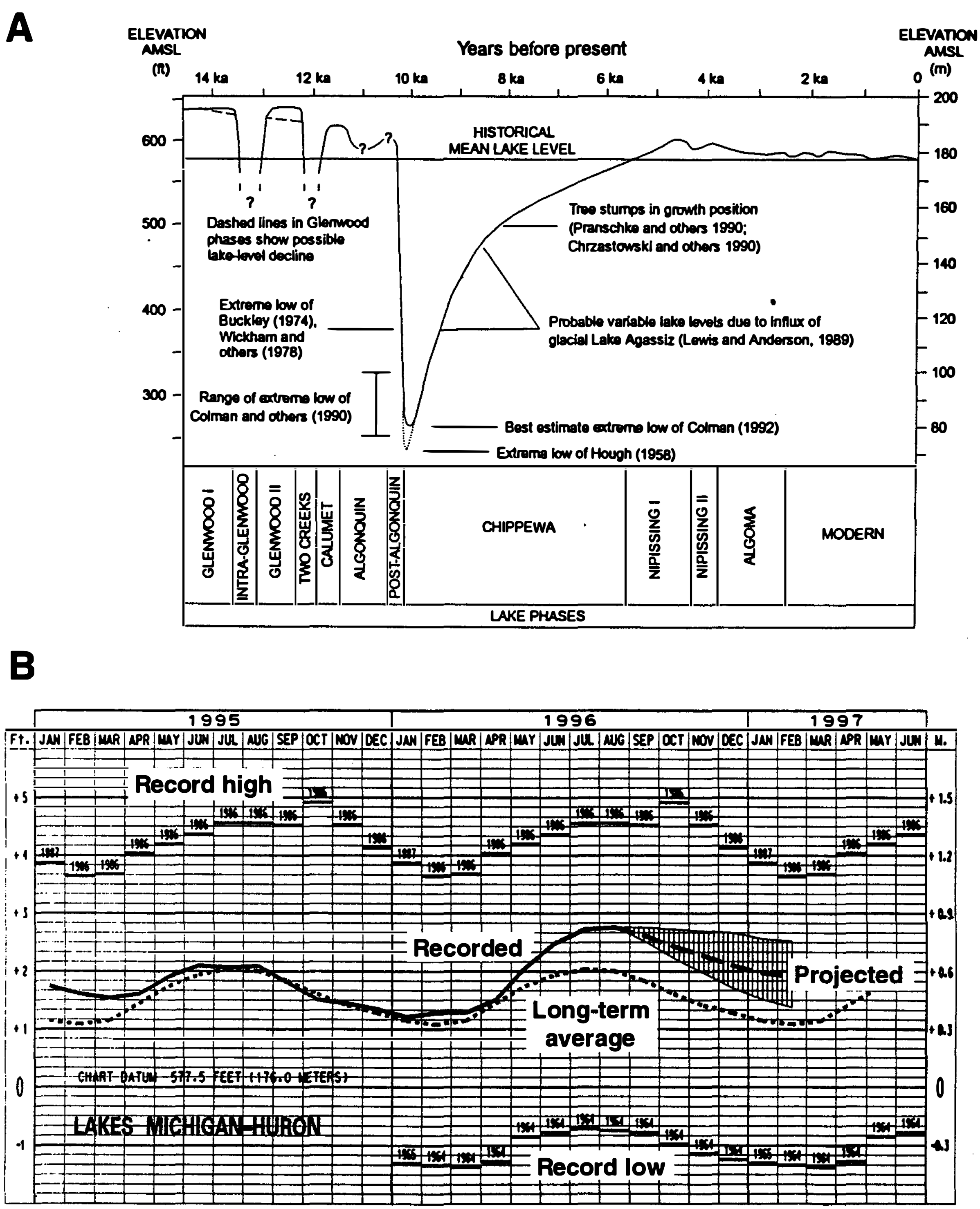

Figure 5. (5A) Lake-level history for the past 14,500 radiocarbon years (from Chrzastowski and Thompson 1994). (5B) Lake-level record for 1995 and the first half of 1996 (from U. S. Army Corps of Engineers, Monthly Bulletin of Lake Levels for the Great Lakes, August 1996).

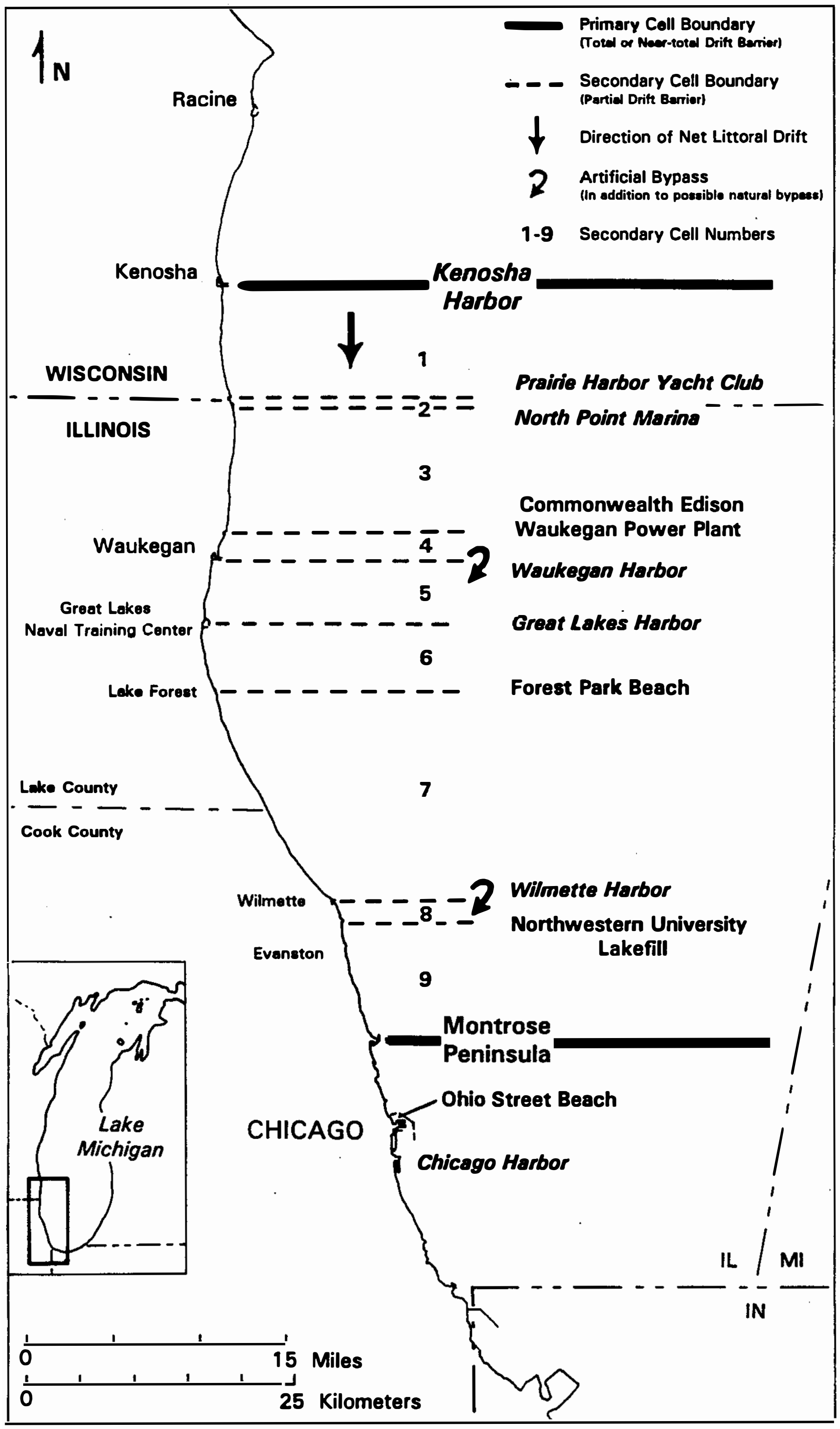

Figure 6. Boundaries of primary and secondary littoral cells along the coast of southern Wisconsin and northern Illinois. Cell boundaries are defined for conditions of natural and artificial bypass as of 1995 (from Chrzastowski and Trask 1995).

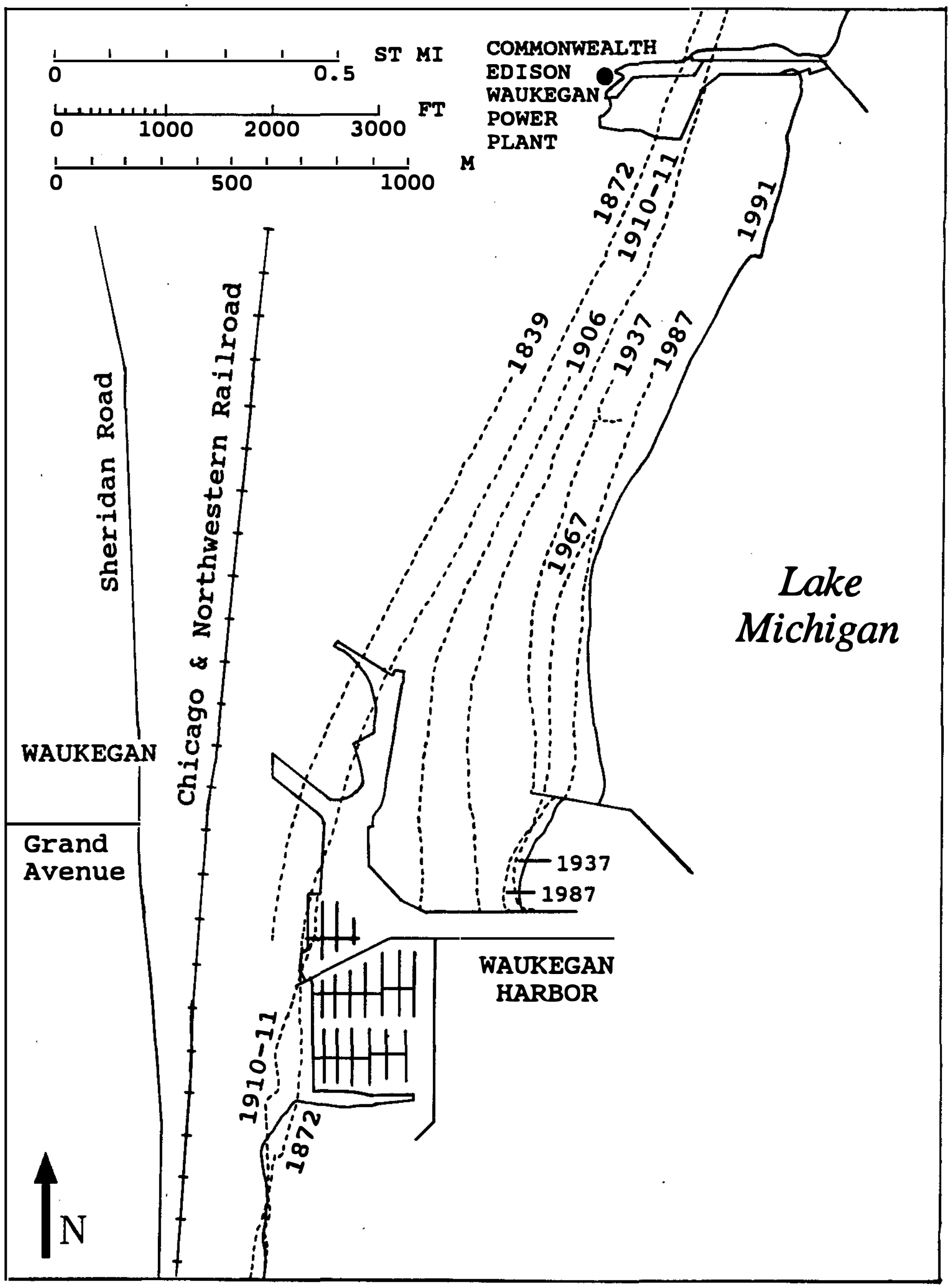

Figure 7. Historical shorelines documenting accretion on the updrift (north) sides of the jetties and shore-attached breakwater at Waukegan Harbor. The harbor jetties were built between 1902 and 1906. The updrift (north) breakwater was initially an offshore structure completed in 1906. The shore attachment for this structure was built in 1930-32 (from Chrzastowski and Trask 1995).

STOP 1
NORTH POINT MARINA

Introduction

North Point Marina is the largest coastal engineering project undertaken along the Illinois coast in the past 50 years. This is the largest Great Lakes marina and one of the largest marinas in the Unites States. The 72-acre basin provides moorage for more than 1500 recreational and commercial boats (fig. 8; also fold-out map at end of this field trip guide). The facility was built by the State of Illinois at a cost of about $47 million. Construction of the basin and breakwaters began in 1987 and was completed in 1989. The marina is operated by the Illinois Department of Natural Resources (DNR).

The construction of North Point Marina resulted in substantial changes to the local coastal setting and coastal processes. The Illinois State Geological Survey (ISGS) has done annual monitoring of beach and nearshore changes to document the impact of the facility on the coastal system. Since the time of construction, severe changes to the local beaches and lake bottom have led to major efforts in both mitigation and remedial action for management of the sand and maintenance of the integrity of shore structures.

Coastal Setting

North Point Marina is located along the erosional zone of the Zion beach-ridge plain (fig. 4). As of 1995, maximum lake-bottom depths within 200 ft of the lakeward perimeter of the breakwaters are 18 ft below Low Water Datum (LWD; also called Chart Datum, fig. 5B). Depths within the marina basin are generally about 8 to 10 ft LWD, although some local shoaling and scour causes shallower or deeper areas. The marina basin straddles the pre-construction (1987) shoreline and was built by a combination of introducing offshore breakwaters and dredging into the beach and backshore (fig. 9).

Historical Coastal Changes

The marina is located along the reach of Illinois lakeshore having the most persistent and rapid historical shoreline recession. Comparison of 120 years of shoreline data from 1872 through 1992 documents a shoreline recession rate averaging 10 ft/yr (fig. 9). The south outer breakwater, which is presently in water depths of 8 to 9 ft LWD, approximates the 1910 shoreline.

Until the late 1970s, the coastal area now occupied by the marina consisted of a low-density residential community called Spring Bluff. Persistent shoreline recession required installation of shoreline protection structures along the lakefront properties. Several generations of shore defense were installed as structures failed. The persistent erosion eventually led to the abandonment of the community and land acquisition by the State of Illinois. Ruins of bulkheads and revetments that once protected residential properties can be seen in the shallow nearshore along the state park shoreline just south of North Point Marina.

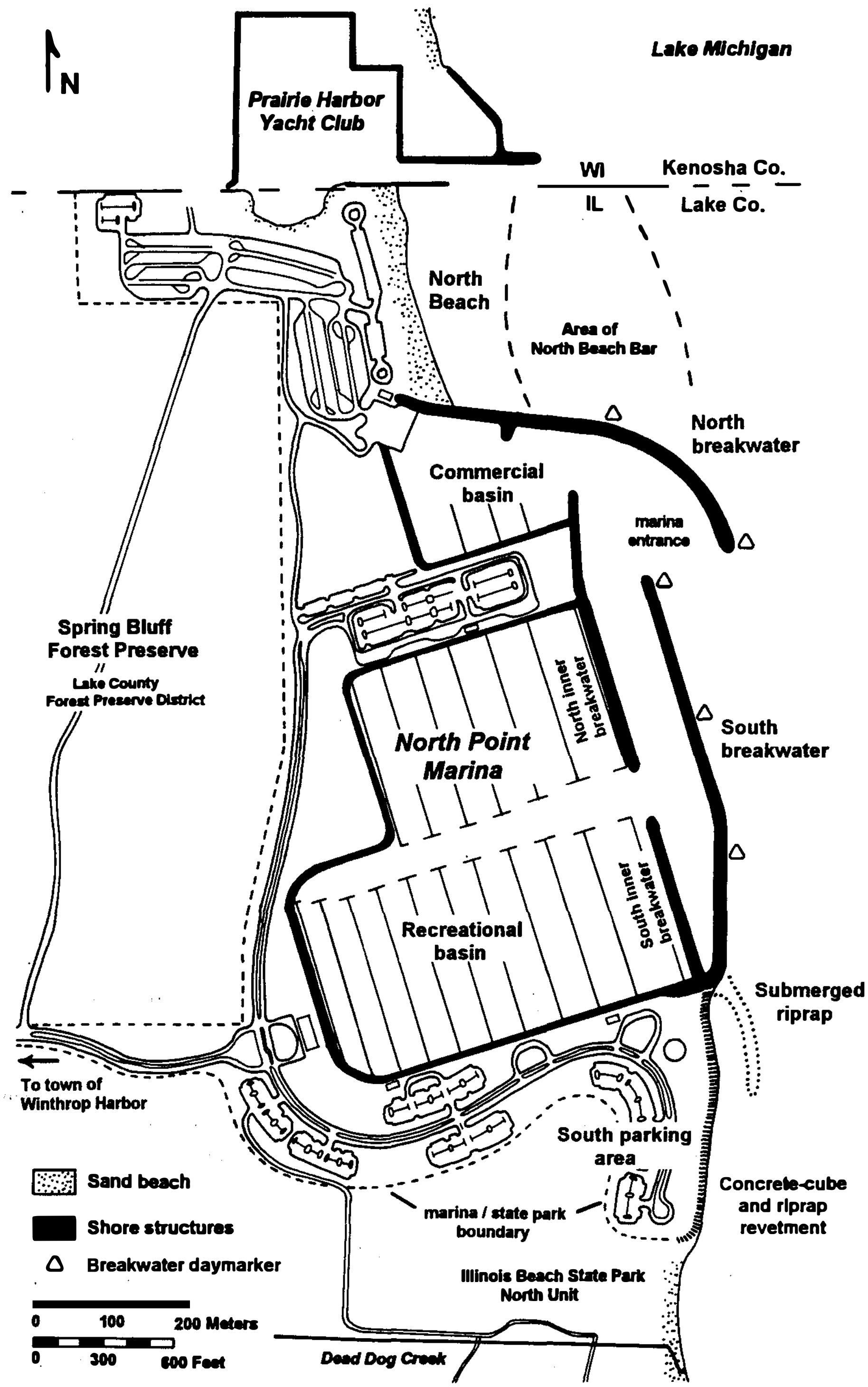

Figure 8. North Point Marina site map and local place names. After the marina breakwaters were constructed in 1987-88, a bar formed updrift of the north breakwater. Sediment dredged to form the marina basin was discharged to the beach and nearshore immediately downdrift (south) of the marina. The south parking area rests atop a remnant of this dredge pile.

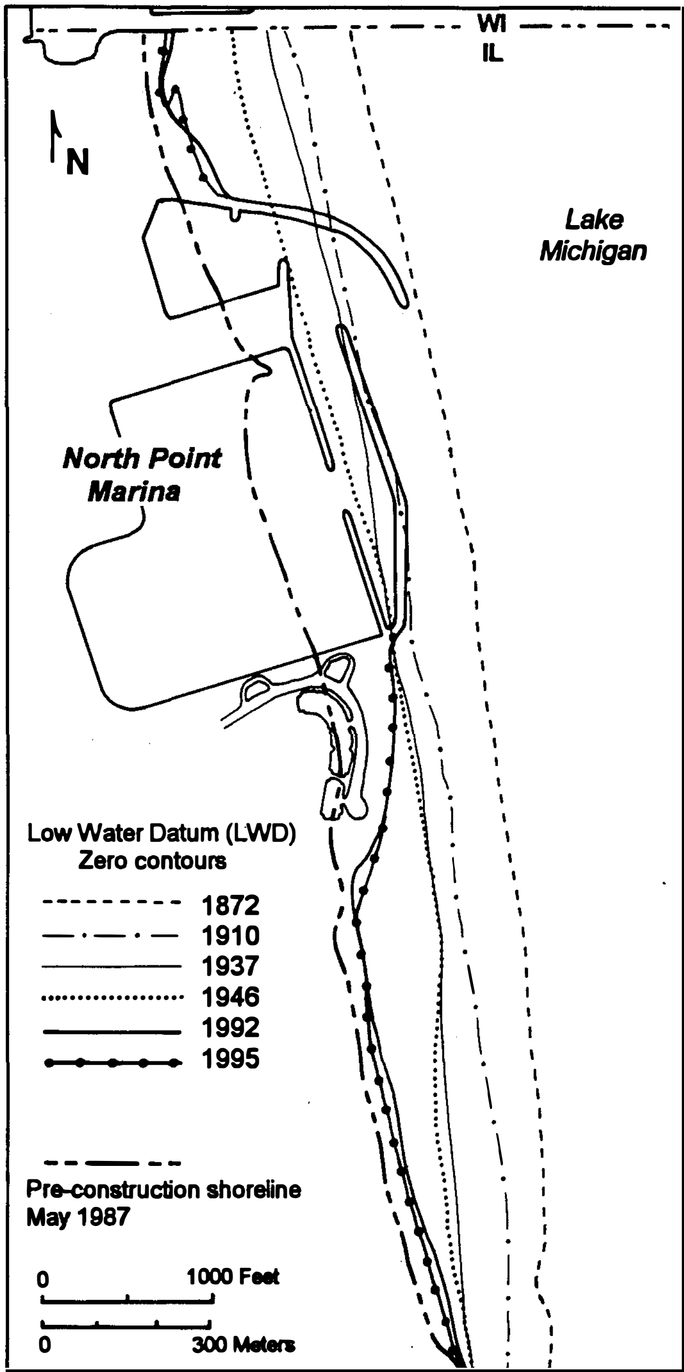

Figure 9. Historical positions of the Low Water Datum (LWD) zero-depth contour along the nearshore at the present site of North Point Marina. The LWD reference is an approximate shoreline. This reference allows a comparison that is independent of differences in lake level for the different years mapped (from Chrzastowski *et al.* 1996).

The dredging of the marina basin resulted in the removal of approximately 1.5 million cubic yards of silt, sand, and gravel. This sediment was discharged by slurry pipe to the beach and nearshore on the south side of the marina at the present site of the south parking area (fig. 8). This sand reservoir was initially intended to be a feeder beach for downdrift nourishment. However, a change in land use to construct the south parking area required that shore protection be placed along the lakeward edge of the fan delta. In late 1988, an arcuate line of riprap was placed along 600 ft of the north end of the fan delta. This riprap was subsequently undermined and is now submerged (fig. 8). Continued beach and nearshore erosion resulted in construction during 1989 and 1990 of a concrete-cube revetment along the beach lakeward of the parking area. This revetment design was one used elsewhere along the state park shoreline (Collinson and Jansen 1985). This revetment was also undermined and is presently a disarray of concrete blocks at or below lake level. Several generations of riprap have been added along this line of failed revetment to provide needed shore protection. The beach has been nourished several times to restore the sand reservoir between this shore protection and the access roads of the south parking area.

While the original 600-ft arcuate segment of riprap was still an exposed feature, the erosion that occurred downdrift from this riprap resulted in the development of a rapidly expanding log-spiral embayment (fig. 10) (Terpstra and Chrzastowski 1992). Development of this log-spiral bay corresponds to the most rapid shoreline recession ever documented along the Illinois coast.

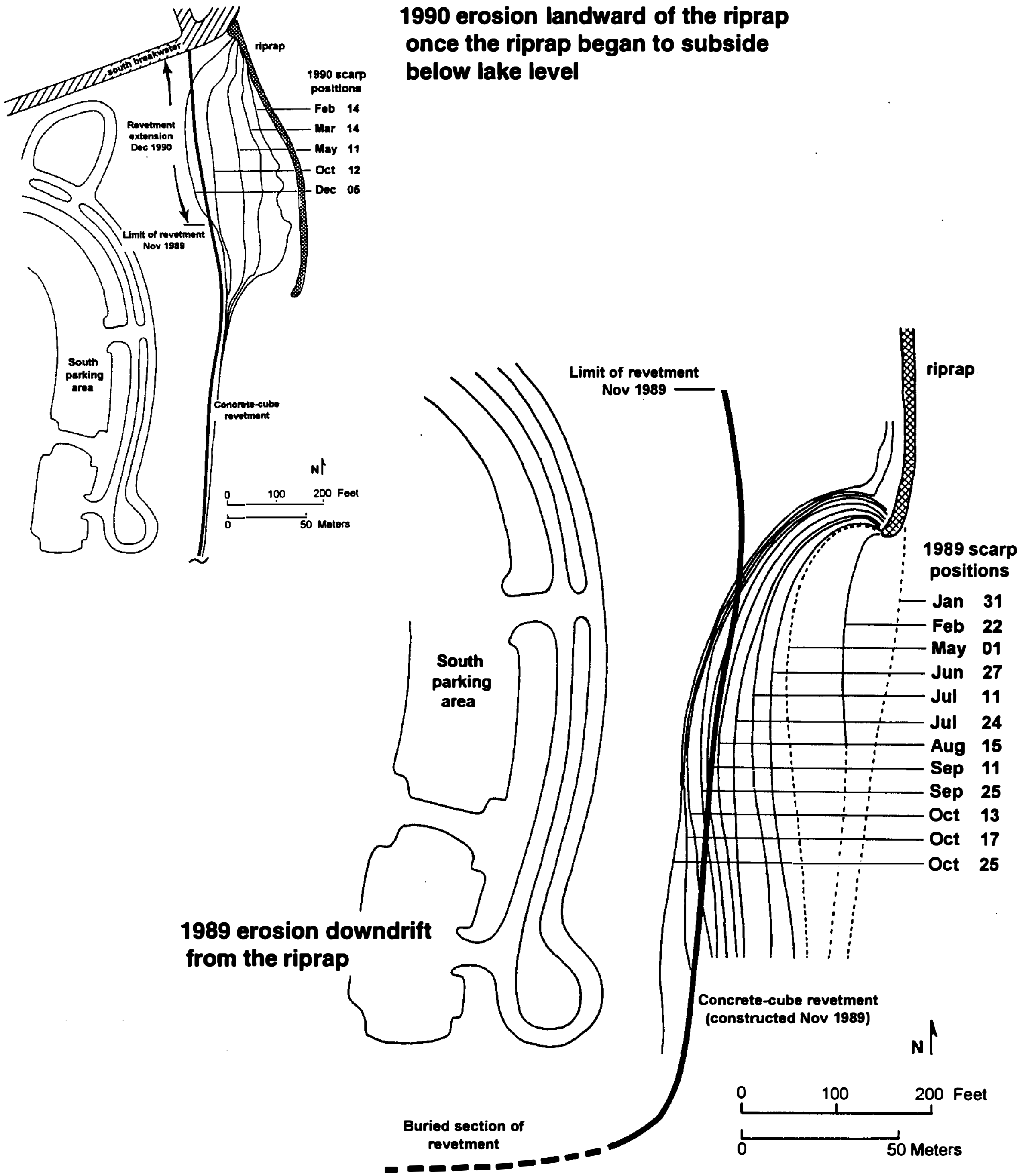

Figure 10. Rapid erosion of a logarithmic spiral embayment in 1989 at the fan delta on the downdrift (south) side of the marina (from Chrzastowski *et al.* 1996). This erosion required construction of a revetment to protect the south parking area. Continued shoreface erosion in front of this area has resulted in several generations of added shore defense.

Coastal Management Issues

Dredging:

Between 1987 and 1995, sand entrapment against the north (updrift) side of the north breakwater resulted in a total of 86,200 cubic yards of accretion, or about 10,800 cubic yards/year. The state and federal permits for construction of North Point Marina require that any littoral sediment entrapped on the updrift side of the marina must be bypassed to the downdrift shore. The Illinois DNR has included funding in the FY97 budget to dredge the updrift accretion and deposit this sand in the downdrift nearshore.

In 1995 and 1996, dredging was done in the entrance area of the marina. This dredging was to remove shoals that began to form soon after completion of the breakwaters in 1989. Additional sand has accumulated in the entrance area in recent years, apparently related to the natural bypass of the north breakwater.

Breakwater Integrity:

As of the time of this field trip (October 1996), there is some concern about the integrity of the north and south outer breakwaters at North Point Marina. A broad sag has been identified in the north breakwater extending along approximately 200 ft and having possibly as much as 2 ft of vertical displacement. Other sites occur along both the north and south breakwaters where the armor stones have apparently shifted, settled, and subsided. A thorough engineering evaluation of the breakwater integrity is planned to begin by the end of 1996 or early 1997.

Defense of the South Parking Area:

Since 1989, beach and nearshore erosion immediately south of the marina has been a threat to the marina south parking area and its access roads. Several generations of concrete blocks and riprap shore defense have been placed along this reach. A persistent problem has been the subsidence of both the blocks and stone as a result of below-water (nearshore) erosion. As of summer 1996, DNR has applied for permits to construct a submerged reef across the nearshore to act as a partial barrier to incoming waves, and to construct a revetment along the shore to prevent additional shore erosion (fig. 11).

Downdrift Erosion:

South of the south parking area, erosion since 1989 has caused a net shoreline recession (fig. 12), despite supplying at least 202,000 cubic yards of beach nourishment to this beach between 1990 and 1995. Ongoing study of the local littoral sediment budget suggests that to halt beach and nearshore erosion, the nourishment volumes must be at least 68,400 cubic yards/year. Estimated cost of such nourishment could be near one million dollars per year. Although beach nourishment is the plan for the near future, the high cost of long-term annual beach nourishment has led to consideration of alternate shore management procedures for the reach between the south parking area and the Camp Logan headland. A primary consideration is the possibility of constructing one or more headlands along this reach and to allow erosion to create arcuate embayments between these headlands. This headland/bay configuration would limit the maximum potential loss of upland areas.

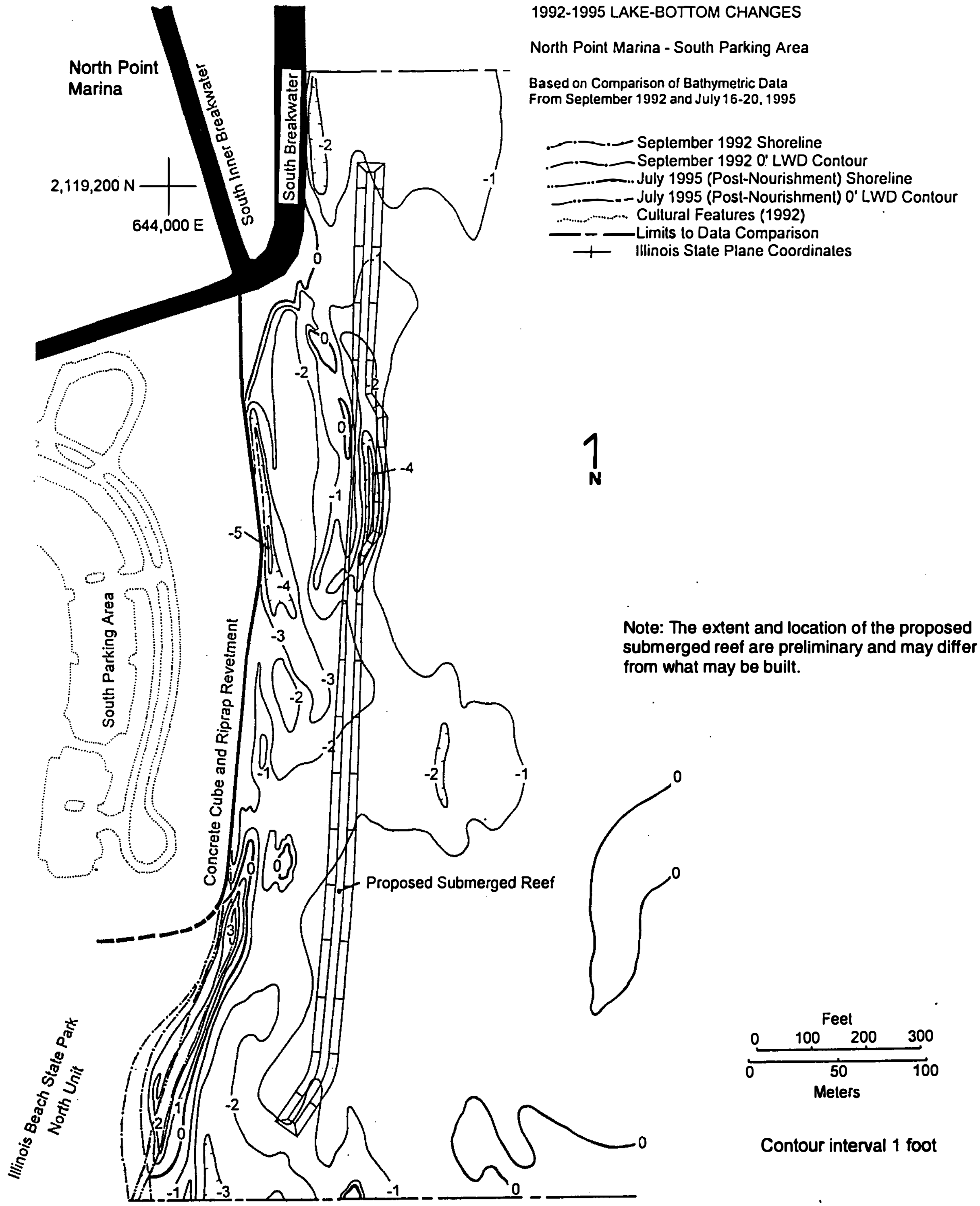

Figure 11. Location of proposed submerged reef to be built lakeward of the North Point Marina south parking area. Reef location is superimposed on an isopach map showing 1992-1995 lake bottom. Negative numbers indicate erosion in feet (from Chrzastowski *et al.* 1996).

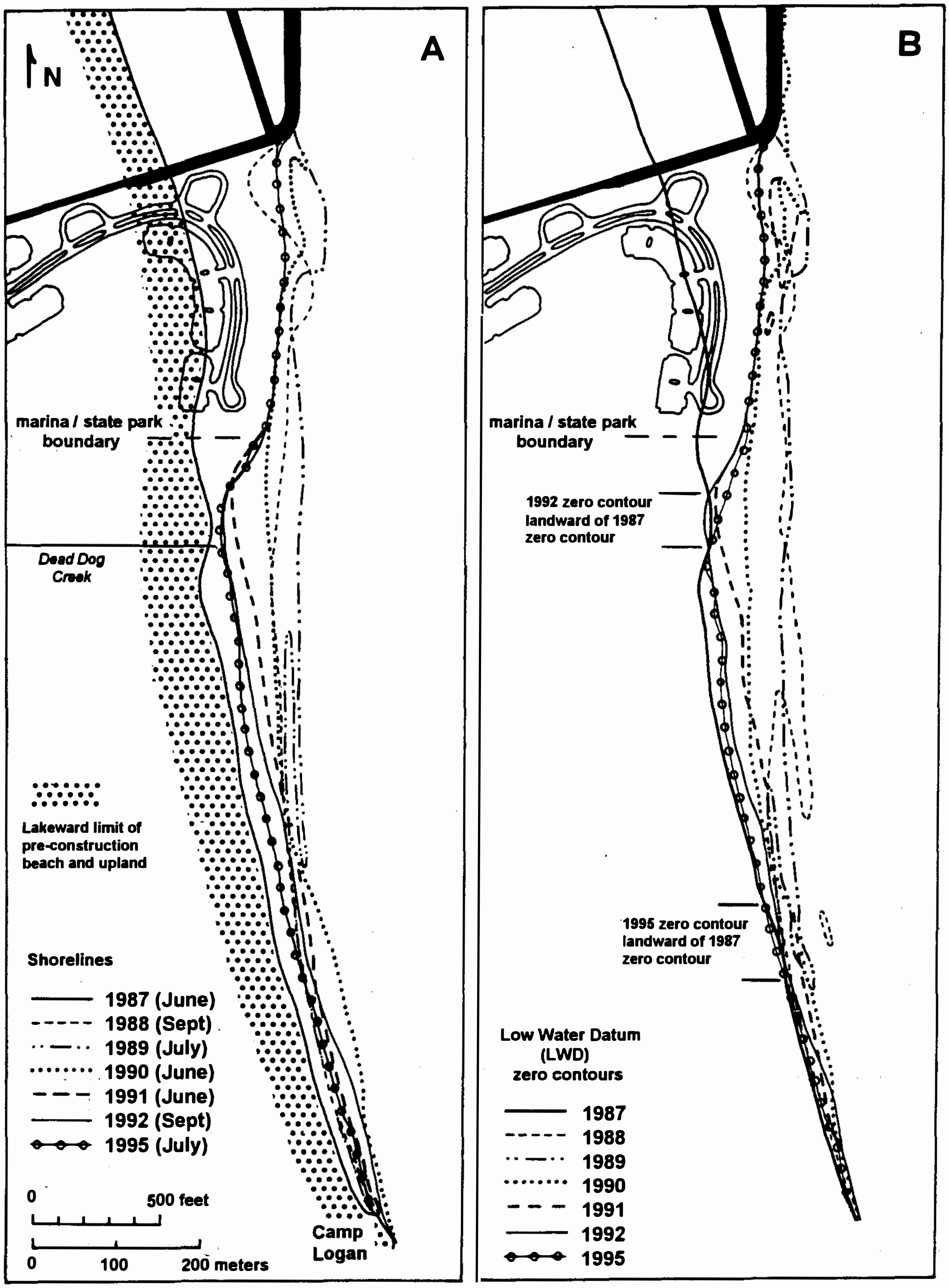

Figure 12. Maps showing 1987-1995 changes in position of the shoreline (A) and the Low Water Datum zero-depth contour (B) between North Point Marina and the Camp Logan headland at Illinois Beach State Park. As of 1995, shoreline erosion (Map A) has yet to reach far enough landward to intercept the pre-construction shoreline (from Chrzastowski *et al.* 1996).

STOP 2
SUNRISE PARK BEACH

Introduction

Sunrise Park is a 1,640 ft long municipal lakefront park in the Village of Lake Bluff, Illinois (figs. 1 and 13). The park includes the top of the local bluffs, the bluff slopes and the beach area at the bluff toe. The park is the site of a 1991 engineering project that restored the native plant community to the bluffs, and provided a wide beach protected by a low-crested spur-breakwater on the updrift (north) side and an armored headland on the downdrift (south) side (Shabica *et al.* 1993). The goal was to design a low-cost system that would provide long-term beach protection and have minimal impact on littoral drift sediments.

Prior to construction, the municipal beach was narrow to non-existent due to inadequate protection by a steel sheet-pile groin system (fig. 14). The building used by a local yacht club was in danger of wave damage. In addition, the bluff was actively eroding due to storm wave attack at the bluff toe. The new facility (fig. 15) was constructed in 1991 at a cost of $750,000. Eleven thousand tons of fill were placed on the new beach and lakebed behind the breakwater. Of this total, 8,500 tons (77%) were required as a pre-mitigation fill by state and federal construction permits to assure that the breakwater and armored headland would have no adverse effects on the littoral drift system by entrapped sand.

Coastal Setting

Sunrise Park is located along the Illinois bluff coast where local bluff heights are about 70 ft above mean lake level. The lakebed and bluffs at this site are composed of Wadsworth Till (Wisconsinan age). The lower bluff is a dense, silty clay till. The upper 10 ft of the bluff is a highly permeable layer of cross-bedded outwash sand and gravel overlain by 1.5 ft of topsoil. The water table lies at the top of the clay till. Seeps are active along this contact even during extended dry periods. Gullies form where the seeps are most active. Thin sand and gravel layers in the clay till often aggravate bluff slides when these layers become saturated.

Shore-protection structures at Lake Bluff typically include stone and concrete rubble revetments and a nearly continuous field of steel-sheetpile groins. The local sand starvation is indicated by many of the groin compartments being void of sand. Downcutting of the clay till is indicated by many of the groins failing on their lakeward ends.

Historical Coastal Changes

The local geology at Lake Bluff suggests that the bluffs have been eroding for the past 5,000 years as modern Lake Michigan attained lake levels at or slightly above historical levels (fig. 5A). Erosion is documented since earliest historical times. Two miles to the north (updrift) is the 104-acre harbor at Great Lakes Naval Training Center (fig. 13). Built in 1923, Great Lakes Harbor formed a near-total barrier to southward littoral transport. The result was sand starvation along the beaches and nearshore at Lake Bluff. In the mid-20th century, the combined erosion of the nearshore, beaches, and bluffs at Lake Bluff was some of the most severe erosion occurring

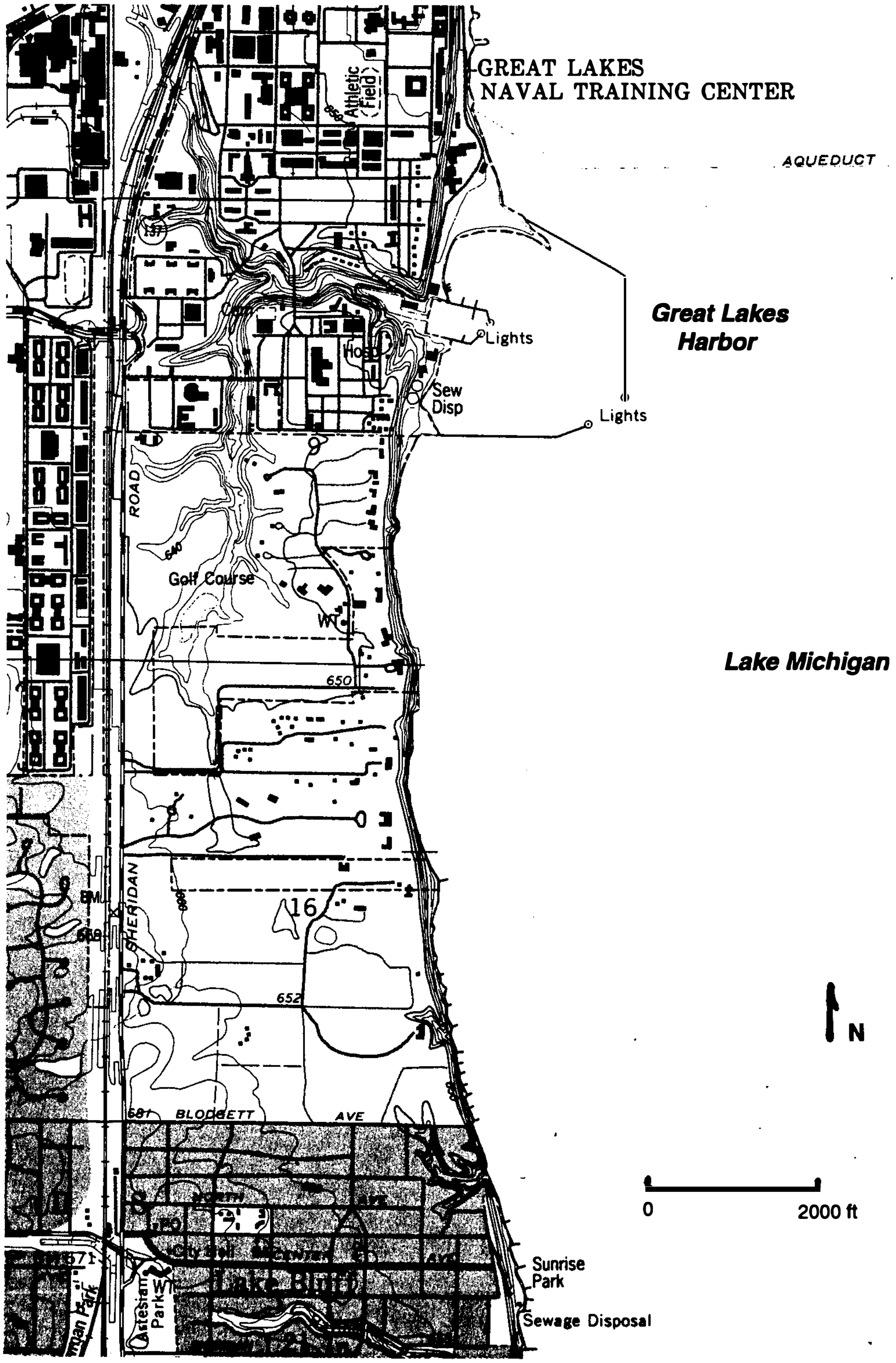

Figure 13. Topographic map of the Lake Michigan coast at Sunrise Park in Lake Bluff and north to the harbor at Great Lakes Naval Training Center (from USGS 1:24,000-scale Waukegan Quadrangle, 1993).

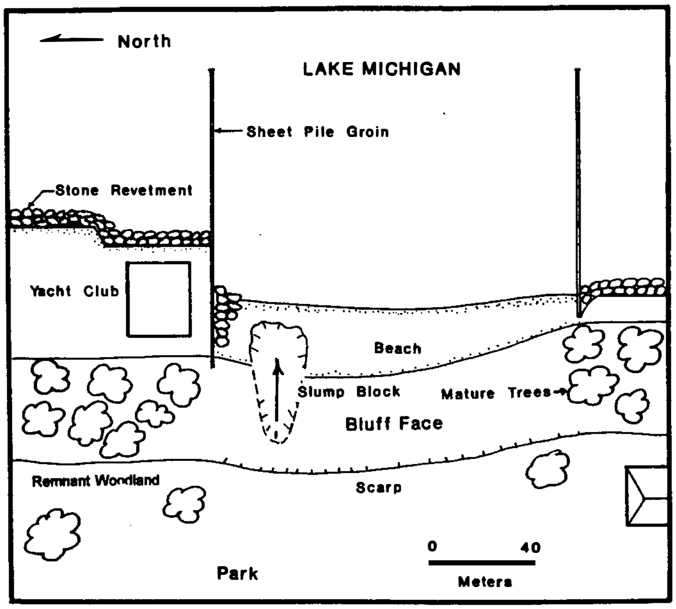

Figure 14. Plan view of Sunrise Park and Beach prior to project construction.

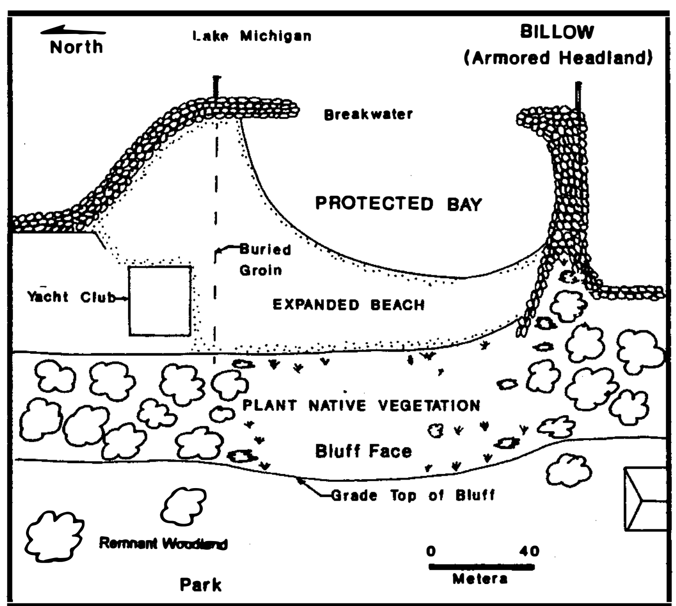

Figure 15. Plan view of Sunrise Park and Beach following project construction.

along the Illinois coast. South of Great Lakes Harbor, between 1937 and 1987, average bluff recession rates were 5.9 ft/yr (Jibson *et al.* 1994). Nearshore erosion has also been severe, and most of the Lake Bluff nearshore has been stripped of sand resulting in erosion across the lake-bottom till (figs.16 and 17). Comparison of 1974-1994 bathymetric data indicate that the local till downcutting has ranged from 0.19 to 0.35 ft/yr (Chrzastowski and Trask 1995).

Coastal Management Issues

Restoration of Bluff Plant Community:

Intense urban development of the Illinois shore of Lake Michigan has nearly eradicated a native plant community adapted to actively eroding glacial-till bluffs. The modern bluffs along the Illinois lakeshore are dominated by later stages of successional plants that typically inhabited the modern stable zones. The bluffs at Sunrise Park have undergone a carefully planned floral restoration to reestablish the natural community of bluff plants.

Prior to urban development, prairie or savanna vegetation at the bluff top was commonly transported down the bluff face in discrete clumps of topsoil and glacial till. In some cases, large-scale rotary failures created massive slump blocks that slid across narrow beaches and extended into the lake. These produced ephemeral vegetated headlands, referred to as "billows". Plants most suited to the original unstable environment were able to tolerate extremes in soil quality, temperature, moisture, and winds. The species makeup of the coastal-bluff plant community was thus a combination of the plants living at the top of the bluff and species tolerant of the high-energy conditions of the bluff face.

During the early part of the 20th century, the bluffs were armored against high lake levels and storm-wave attack. This slowed or halted the natural movement of the bluff face that was essential to the high diversity of plant community along the eroding bluffs. In addition to protecting the bluff toe from erosion, large-scale planting of woody plants was undertaken in an effort to stabilize soil movement. These woody plants, such as black locust, cottonwood, aspen, and ash, quickly overtook the newly protected bluff faces. Alien woody plants (Rhamnus catuartica and honeysuckle) also colonized the bluffs or were planted. The resulting shade and aggressive growth suppressed the native plant community. Fragmentation of the original eroding bluff community resulted in a net loss of available natural seed source for colonization of areas with recent soil movement.

To assist in planning the development of a "natural state" plant community on the Lake Bluff site, an existing ecological model was located and studied. One of the very few and probably the best remnants of a natural plant community along an actively eroding glacial-till bluff occurs approximately 11 miles south of Lake Bluff at Fort Sheridan. All seral stages are present at this site.

All native herbaceous plants present at the Fort Sheridan site were included in the planting list for Sunrise Park. What wasn't commercially available as seed was collected at Fort Sheridan and grown under contract as plugs for future planting. Additional plants not found at the Fort Sheridan site but thought to have grown at other sites (and since lost to erosion) were also included in the initial seed mix. A cover crop was included to protect the new seeding and recently redistributed soils from surface erosion. Annual and biannual flowers were also included to provide immediate aesthetic appeal.

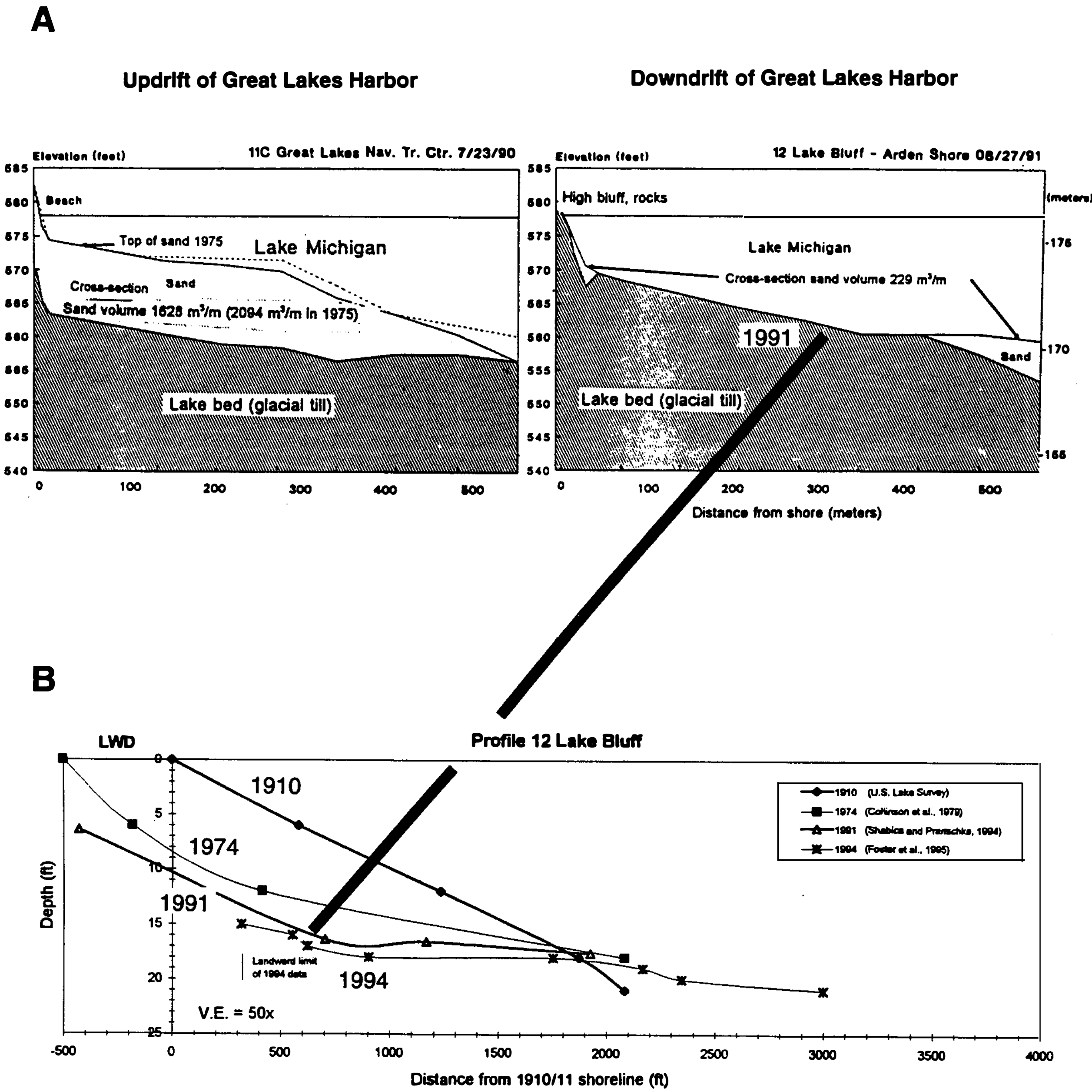

Figure 16. Beach and nearshore profiles in the vicinity of Lake Bluff. (A) Comparison of nearshore sand thickness on the updrift (north) side of Great Lakes Harbor and along the nearshore at Lake Bluff. The Lake Bluff profile is typical of much of the nearshore to the south of the harbor, which has been stripped of nearshore sand and consists of exposed glacial till (from Shabica and Pranschke 1994). (B) Beach and nearshore profile comparisons at Lake Bluff documenting the persistent nearshore erosion from 1910 to 1994 (from Chrzastowski and Trask 1995).

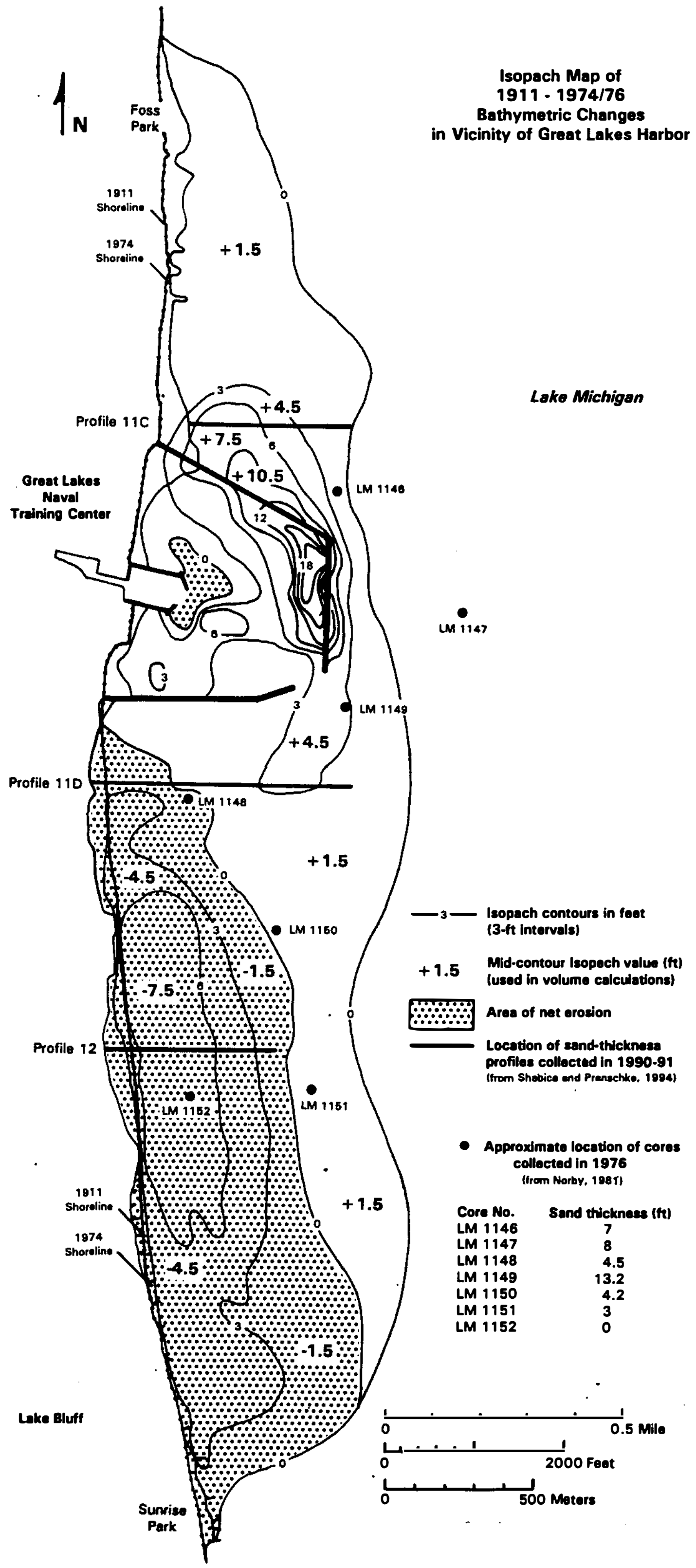

Figure 17. Isopach map of lake-bottom changes between Great Lakes Harbor and Sunrise Park based on a comparison of 1911 and 1974 / 76 bathymetric data. Severe nearshore erosion is documented downdrift (south) from the harbor. An accretional lobe extending downdrift from the lakeward extent of the harbor indicates that although the harbor may have been a near-total barrier to littoral drift when first built in 1923, by 1974 natural bypass of the harbor had occurred (from Chrzastowski and Trask 1995).

Sunrise Park Sand Monitoring:

State and federal permits for construction of the breakwater-defended beach at Sunrise Park required that the beach and nearshore sand be monitored annually for five years. The project beach and a nearby "control" beach were surveyed by rod and transit from 1991 through 1995 (figs. 18 and 19). Specifications for the surveys require 50-ft spacing between profiles. The required survey-point spacing was 10 ft across the beach and at break points where the vertical change in the profile was more than 0.5 ft. The offshore extent was 25 ft lakeward of the shoreline and 20 ft beyond the lakeward end of groins. The survey accuracy requirements were $\pm$ 0.1 ft vertical and $\pm$ 1 ft horizontal.

If after two and four monitoring seasons the project site had a net gain in sand per linear foot of shoreline relative to the control beach, the Lake Bluff Park District was required to add the equivalent type and amount of sand to the littoral drift system immediately downdrift (south) of the project site. The minimum threshold amount of trapped sand to require mitigation was 1,000 cubic yards. The specific wording for the mitigation was as follows:

> *"Mitigation should be implemented for any removal of littoral material from the transport system. This will be represented by sediment retained in the project beach area, particularly in the leg of the breakwater structures, exceeding what is naturally occurring by background effects, and by material in the updrift bay."*
>
> *USACE MEMORANDUM FOR CHIEF- CNCC-ED-GC, 12 September 1991*

Survey results showed that between 1992 and 1995 both beaches lost sand to the littoral drift system (table 1). The project beach showed a small gain from 1992 to 1994 and a loss from 1994 to 1995. The project beach net change from 1992 to 1995 was a loss of 620 cubic yards (-0.9 cu yds per linear foot of shoreline). The control beach consistently lost sand for a total loss of 1,247 cubic yards (-4.6 cu yds per linear foot of shoreline).

Table 1. Comparison of changes in sand volume on the Sunrise Park project beach (beach width 689 ft) and the control beach (beach width 271 ft).

Survey Years	Project Beach	Control Beach	Lake Level
1992-1994	+0.6 cu yds	-3.7 cu yds	+0.90 ft
1994-1995	-1.5 cu yds	-0.9 cu yds	-0.66 ft
1992-1995	**-0.9 cu yds**	**-4.6 cu yds**	**+0.24 ft**

Volumes for the project and control beaches are in cu yds per linear foot of shoreline.

Discussion: The breakwater protecting the beach was designed to minimize sand loss on the Lake Bluff groin-protected beaches. The control beach, protected by sheet pile groins, lost sand over three years of monitoring regardless of whether the lake rose or fell. However, higher lake levels do correspond with higher levels of sand loss to the control beach. The project beach had a smaller loss of sand over the three-year period, and seems to be more effective at holding sand during varying lake levels.

Although concerns in the construction permits focused on sand entrapment, the opposite has occurred, with the project beach experiencing a net loss of sand. The fact that sand loss from the project beach between 1992 and 1995 was small compared to the control beach is evidence that the breakwater system at the project beach is functioning as an excellent sand-retention system.

Over the long term, the overall sand loss to both the project and control beaches will be exacerbated by lakebed downcutting. Bathymetic contours (fig. 19) show that the nearshore profiles on both beaches have steepened over the survey period, but this is more obvious on the control beach than on the project beach.

Lake-bottom Erosion:

The depletion of nearshore sand (and gravel) across the Lake Bluff nearshore is becoming a serious coastal management issue. This depletion has increased nearshore depths allowing greater wave energy to impact the shore. Even more detrimental, the depletion of the nearshore sand cover has allowed waves to erode the exposed glacial till. The downcutting of this till is "non-reversible" erosion. That is, once this downcutting occurs, no coastal process can return the till to the pre-erosion elevation. Till downcutting is considered by some to be the most serious coastal management issue in southern Lake Michigan.

At present, the U.S. Army Corps of Engineers is considering a "permanent" remedial action to halt the till downcutting by blanketing the nearshore with 3- to 10-inch pebbles and cobbles (Chicago Tribune, April 27, 1996, pages 1 and 11). The details of this remedial action have yet to be finalized, but the Corps has suggested that this pavement be designed to be 8 inches thick, about 500 ft wide, and have its landward edge about 20 ft from the shoreline. The pavement is tentatively planned for 22 miles of lakeshore extending from Waukegan south to Wilmette (fig. 1). The total estimated cost is $24 million.

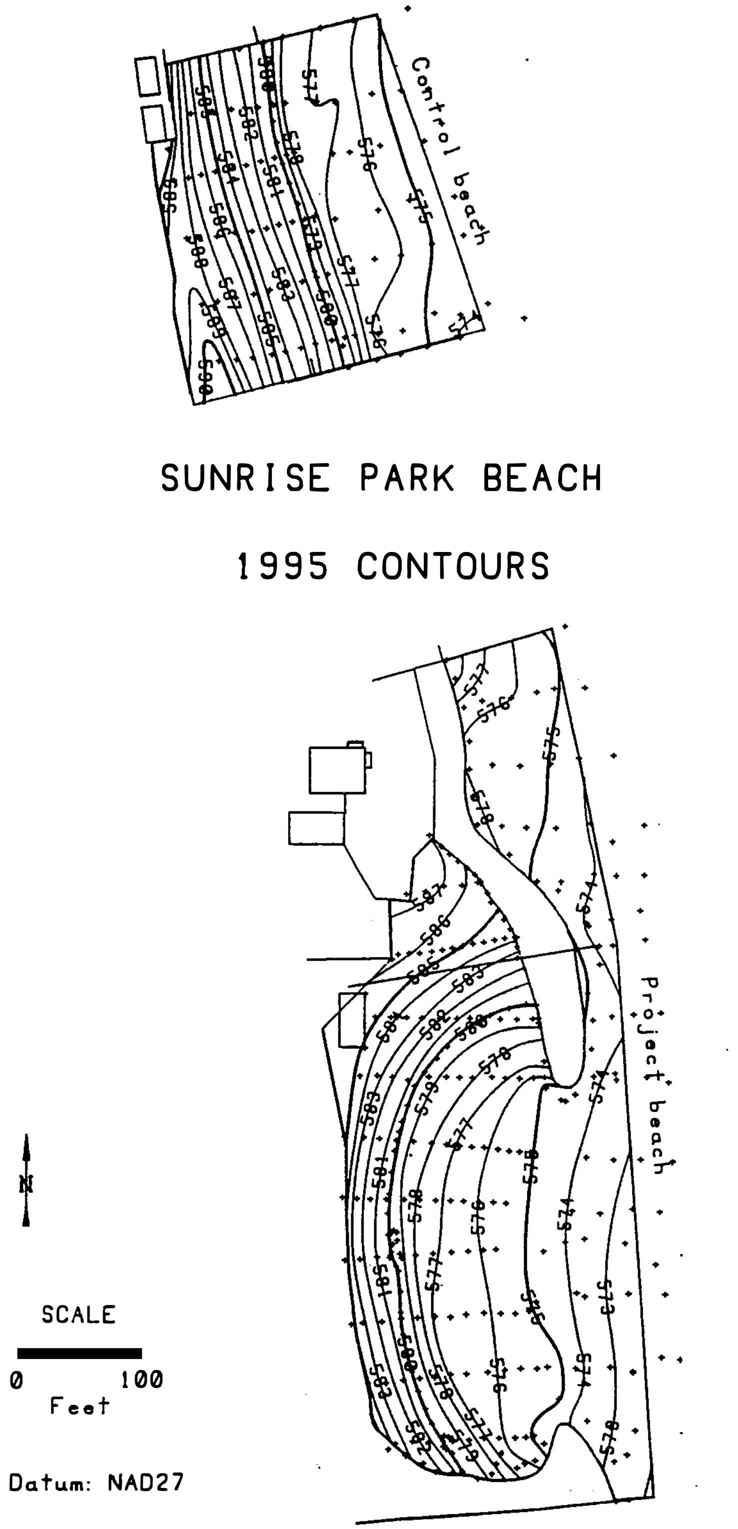

Figure 18. Contour maps resulting from 1995 beach and nearshore profile surveys at the Sunrise Park project beach and the nearby control beach.

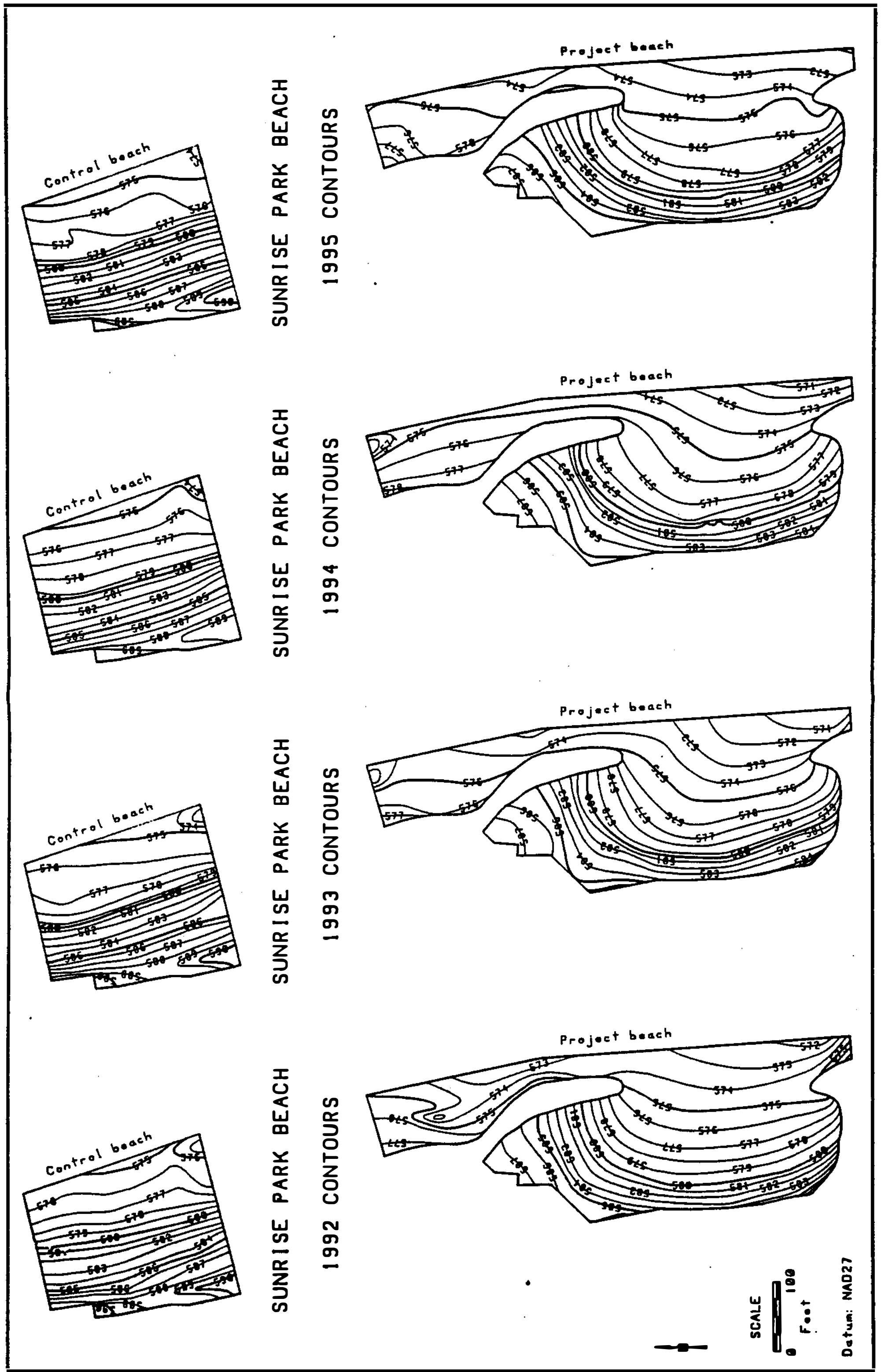

Figure 19. Comparison of 1992 to 1995 contour maps for the Sunrise Park project beach and the nearby control beach. Elevations are in feet above NAD 1927.

STOP 3
FOREST PARK BEACH

Introduction

Forest Park Beach is a 22-acre lakefront development built for both shore protection and recreation (Anglin *et al.* 1987). The facility was constructed in 1986-1987 by the City of Lake Forest at a cost of $9 million. Prior to construction, the municipal park and beach at this site consisted of a groin field protecting a narrow beach and bluff toe. The present facility combines a series of shore-attached rubble mound breakwaters, four embayed beaches, a boat-launch basin, parking, walkways, promenades, and several service buildings.

Because of concerns about possible adverse downdrift impacts caused by construction of Forest Park Beach, a post-construction monitoring program was conducted in 1987 and 1988, and then again annually from 1991 to 1995. The primary data collection involved annual beach and nearshore profiling across a monitoring area extending about 1,000 ft both updrift (north) and downdrift (south) of the facility (fig. 20). The monitoring from 1991 through 1995 was conducted by the City of Lake Forest. The Illinois State Geological Survey (ISGS) duplicated selected work for the purpose of quality assurance and quality control. The reports for the fifth and final year of this five-year monitoring program were completed in 1996 (Magnus *et al.* 1996 ; Chrzastowski and Trask 1996).

Coastal Setting

Forest Park Beach is located along the base of bluffs that rise to about 80 ft above mean lake level. The setting is similar to that of Sunrise Park (Stop 2), but this location is farther downdrift (southward) from Great Lakes Harbor, and thus has experienced less of the adverse downdrift impacts caused by the naval harbor. The rubble mound breakwaters for Forest Park Beach were built into maximum water depths of 11 ft LWD. Since construction, lake-bottom accretion has occurred along the lakeward margin of all of the breakwaters. A sand lens covers most of the lake bottom out to a distance of about 400 to 600 ft offshore. At greater distance, the lake bottom consists of exposed till with patchy areas of sand veneer.

Historical Coastal Changes

Prior to the 1986-1987 construction of Forest Park Beach, the municipal beach and park at this site had suffered from long-term loss of beach and nearshore sand. The groin field was nearly empty. Higher than average lake levels were allowing storm waves to threaten the bluff toe. Improved shore protection was the primary impetus for construction.

The construction project involved a small amount of lakefilling to improve the width of the parkland at the bluff toe. However, the overall footprint of the facility was kept fairly small to minimize coastal impacts. The most lakeward breakwater is located 180 ft lakeward of the pre-construction shoreline. The beaches were constructed with a cover of "birds eye sand" which is a fine gravel having a median diameter of 2.8 mm. This sediment was used as a compromise: the coarsest grain size to assure long-term residence, but still fine enough to be compatible with beach recreation (Anglin *et al.* 1987).

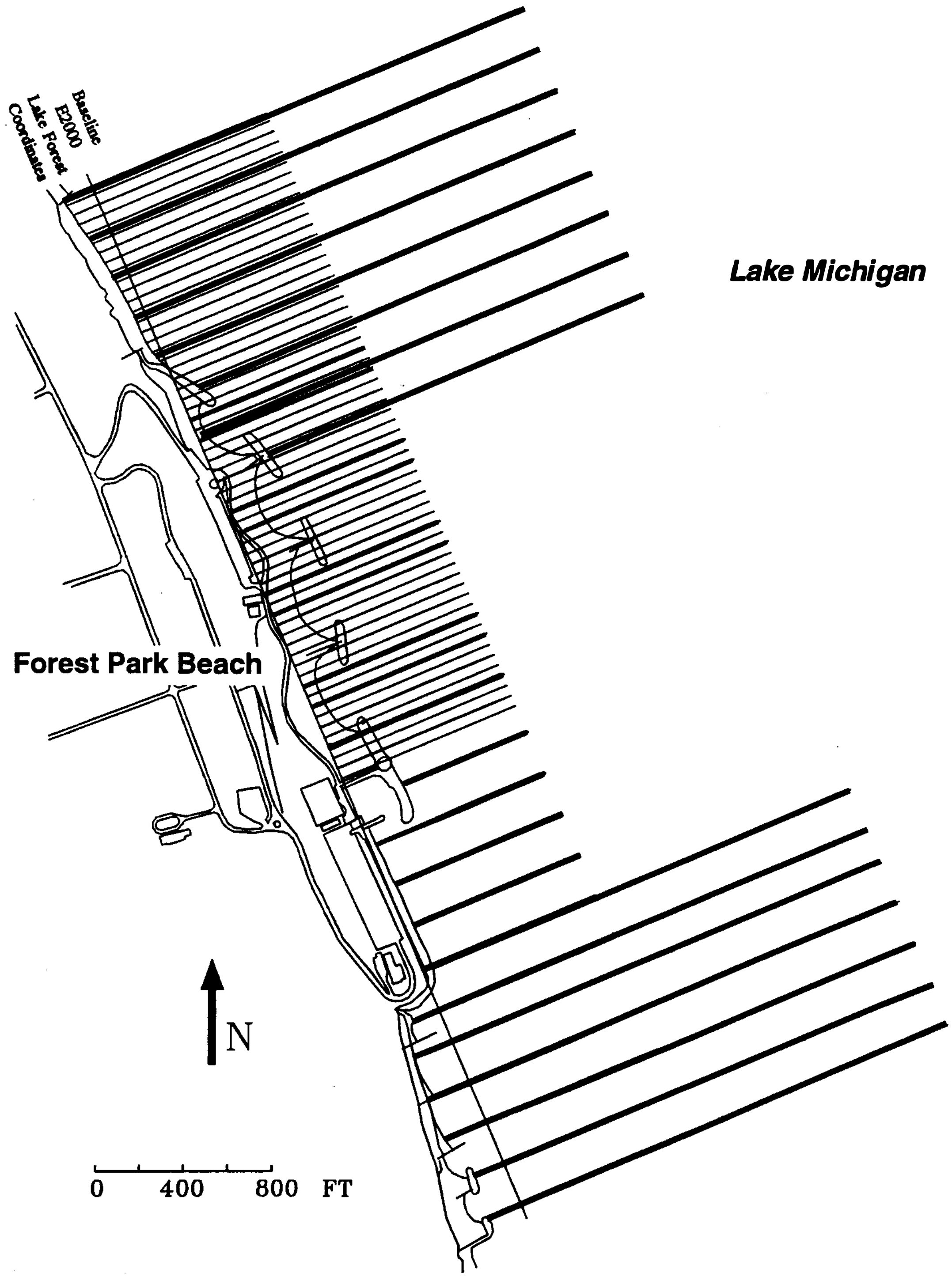

Figure 20. Scheme of profile lines used in the beach and near shore coastal monitoring at Forest Park Beach. A total of 62 "short lines" reach up to 1,000 ft offshore. Profile data are collected along these short lines with prism pole and total station. A total of 15 "long lines" reach up to 2,300 ft offshore. Profile data are collected along these lines with combined prism pole/total station and fathometer (from Chrzastowski and Trask 1996).

During the pre-construction planning and design, the best available data indicated that the volume of littoral sediment passing Forest Park Beach was nearly zero, or "lean" at best (Anglin *et al.* 1987). The facility was anticipated to cause no significant entrapment of littoral sediment because of the lean transport volumes, the minimal shoreline protrusion of the facility, and the arcuate overall plan form which would facilitate natural bypass. However, initial monitoring in 1987 and 1988 determined that a bar had accreted against the north breakwater. The accretion volume was approximately 10,000 cubic yards.

Documenting the development of this bar had two primary impacts. First, the City of Lake Forest agreed to provide beach nourishment totaling 10,000 cubic yards to the downdrift nearshore to compensate for the updrift entrapment. This nourishment was supplied in increments in 1991, 1992, and 1993. Second, further monitoring was initiated to run five years from 1991 through 1995.

The 1991-1995 monitoring program documented the continued accretion along the lakeward perimeter of the facility as well as within the beach cells. This accretion was establishing a sand bridge for natural bypass of the facility. The bar that was observed in the first couple of years following construction was the beginning of this sand bridge and bypass pathway. As of 1995, the downdrift (southward) leading edge of the wedge of lakeward accretion was positioned lakeward of the southernmost beach cell (fig. 21). A lake-bottom depression opposite this beach cell has contributed to slowing the advance of this accretion wedge since 1993.

Coastal Management Issues

Downdrift Impacts:

Although 1987 to 1995 bathymetric comparison does show that net erosion has occurred in the nearshore downdrift of the facility (fig. 21), no adverse impact to any of the beaches or shore protection structures has been documented. The downdrift erosion has occurred only in the nearshore zone; no net erosion has occurred across the beaches. None of the nearshore erosion has depleted the sand cover to expose the underlying glacial till. Because this was a sand-starved nearshore before the construction of Forest Park Beach, it is not possible to determine if this nearshore sand loss can be attributed solely to the facility.

Sand Entrapment:

Since construction, net accretion has occurred updrift, within, and adjacent to the facility. Monitoring data indicate that it would be an error to assume that all of the accretion is a permanent entrapment. The local lake bottom is extremely dynamic, and changes in the supply of sand volume from updrift, changes in storm frequency and duration, and changes in lake level are a few of the major factors that could change the volume of sand entrapment with time. For example, until 1994, net accretion persisted in the monitoring area and the total post-construction accretion volume was 69,000 cubic yards. Between 1994 and 1995, net erosion dominated the monitoring area, and this reduced the total post-construction accretion to 45,800 cubic yards. The dynamic nature of local conditions has been a prime factor why state and federal regulators have not required that the City of Lake Forest provide downdrift nourishment to compensate for the total entrapment.

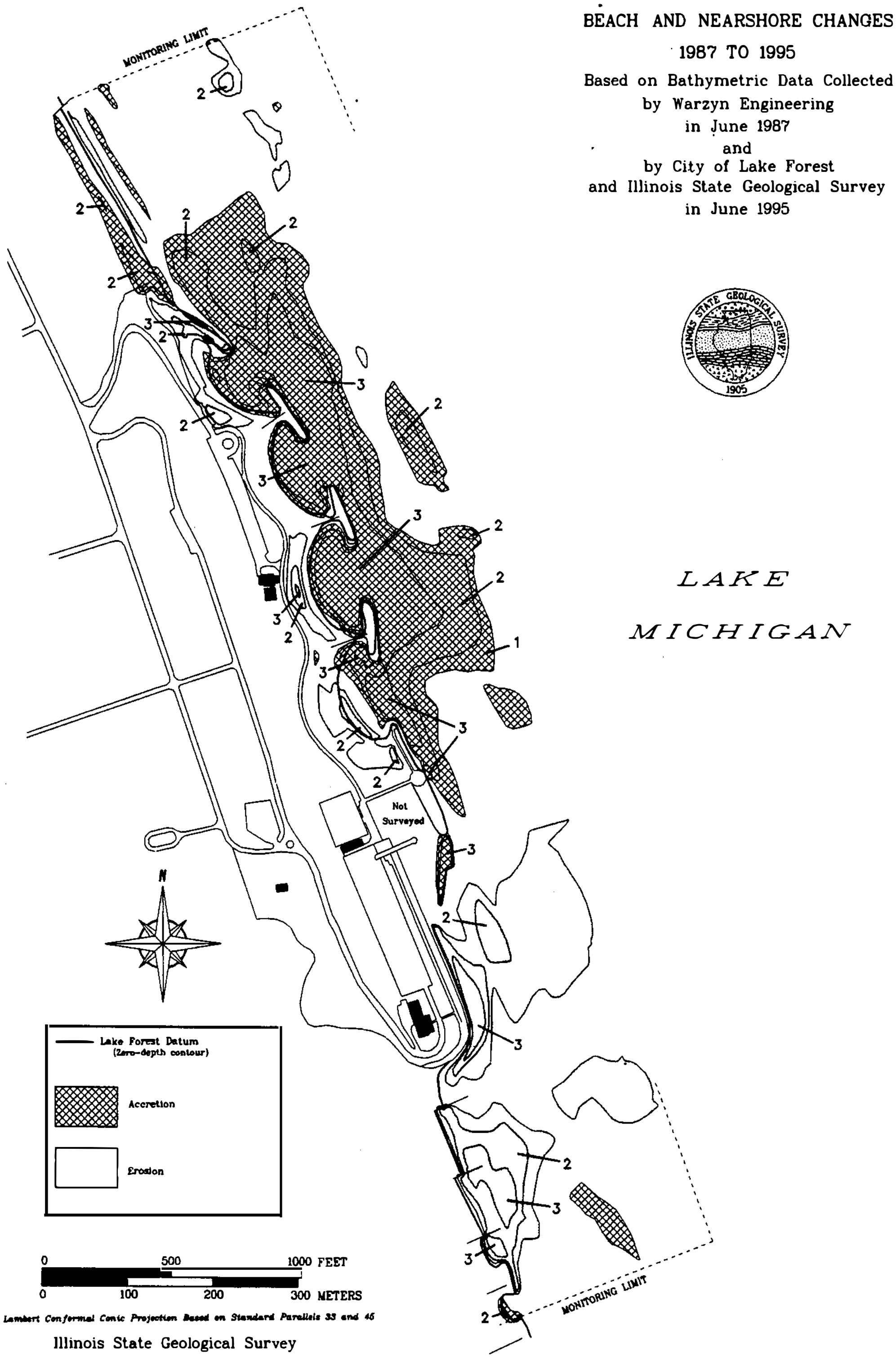

Figure 21. Isopach map of lake-bottom changes in the Forest Park Beach monitoring area based on a comparison of 1987 and 1995 bathymetric data (first eight years following construction). Only changes greater than 1 ft are shown (from Chrzastowski and Trask 1996).

Source of Entrapped Littoral Sand:

From the time of first identifying an updrift bar, the source of this sand was an enigma, because Great Lakes Harbor was assumed to be a near-total barrier to littoral transport, and few sources of sediment supply were thought to exist as a result of erosion across the bluffs, beaches or nearshore between Great Lakes Harbor and Forest Park Beach. Recent studies sponsored by the U.S. Army Corps of Engineers Chicago District provide a new insight. A compilation and comparison of historical and recent bathymetric data between Waukegan Harbor and Forest Park Beach indicate that Great Lakes Harbor has in fact had natural bypass since at least 1974 (Chrzastowski and Trask 1995). Since about that time, sediment dredged from the Waukegan Harbor entrance has been disposed of downdrift (south) of the harbor. If this dredged sand bypasses Great Lakes Harbor, then Forest Park Beach becomes the first major impediment to littoral drift that is intercepted in the southward littoral transport (fig. 22). Thus a prime source for the sand entrapped at Forest Park Beach may be sediment dredged and bypassed from Waukegan Harbor. A tracer study is needed to verify that sand from the Waukegan Harbor dredge disposal site does in fact become entrapped at Forest Park Beach.

Dredging at the Boat-Launch Basin:

Since 1989, annual dredging has been necessary to maintain a desired minimum depth of about 6 ft in the boat-launch basin and its approach. The need for this annual maintenance dredging is considered one indication that limited natural bypass of Forest Park Beach has occurred since at least 1989. Sediment dredged from the boat-launch basin is disposed of in the downdrift nearshore. Between 1989 and 1995 a total of 22,440 cubic yards have been dredged from the basin. This is a seven-year average of 3,200 cubic yards/year. It is anticipated that the sand bridge will eventually build southward across the entrance to the boat-launch basin. If this occurs, a greater volume of sediment will likely need to be removed in the annual maintenance dredging, primarily from across the sand bridge.

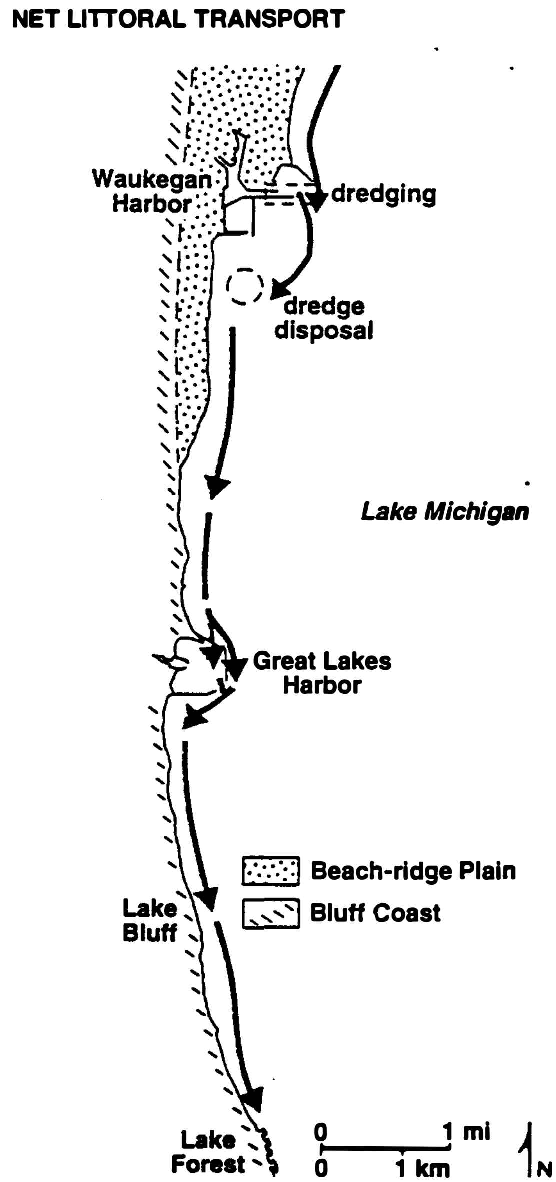

Figure 22. Assumed transport pathway for littoral sand that has been trapped at Forest Park Beach. Because little if any contribution of sand to the littoral stream can be supplied from bluff, beach, or nearshore erosion, a likely source of sand is the artificial bypass done with the dredge spoil from Waukegan Harbor, as well as natural bypass that may be occurring. On average, the U.S. Army Corps of Engineers annually dredges and bypasses approximately 34,000 cubic yards of sand from Waukegan Harbor (from Chrzastowski and Trask 1995, 1996).

STOP 4
DAWES PARK

Introduction

The City of Evanston has more lakefront parkland than any municipality along the Illinois shore other than Chicago. Dawes Park and the neighboring parkland to the north and south provide examples of Evanston's groin-anchored beaches and riprap-defended parkland.

Coastal Setting

All of the Evanston lakeshore lies along the Chicago/Calumet lake plain (fig. 2). The pre-development setting along the Evanston shore consisted of narrow beaches beneath a low bank where storm waves would erode into the glacial till of the lake plain. As development occurred along the Evanston lakeshore, shore defense was added in the late 1800s and early 1900s to halt the erosion along the low banks of till. In recent times, the combination of minimal sand input from littoral drift and active lakebed erosion has caused failure of many of the shore-protection structures in this area.

Historical Coastal Changes

In the 1860s, the City of Evanston was a growing town with lumber being its primary shipping industry. The city had two large piers used for commercial and passenger traffic. The Davis Street Pier was 700 ft long and the Dempster Street Pier was one half mile long. These piers formed near-total barriers to littoral drift and trapped large sand fillets by 1900. At this time, the railroad industry was growing rapidly while ship traffic dropped off precipitously. Commercial use of the piers came to an end soon thereafter. Ruins of these piers appear in photos as late as the 1930s.

As Evanston's urban growth continued in the late 1800s, extensive groin fields were installed to protect eroding lakeshore bluffs. This early generation of groins was constructed of wood. These were later replaced by concrete and steel modular structures after the end of World War II.

Littoral sediment supply to the central and southern Evanston shore was significantly curtailed following construction of the lakefill for expansion of Northwestern University located about one half mile north of Dawes Park (fig. 23). In 1962, Northwestern University began a 27-month project to create a 152 -acre lakefill for expansion of the university campus. The total project cost was approximately $6.5 million. The project consisted of a 2,800 ft long bulkhead on the perimeter of the lakefill. This structure reached 1,200 ft east of the pre-construction shoreline and extended into maximum depths of 9 ft LWD. The Northwestern lakefill initially formed a near-total barrier to littoral transport. Profile data on the lakefill perimeter indicate that a sand bridge had formed by the late 1980s and natural sand bypass was then occurring (fig. 24).

In recent years, many of the groin fields along the Evanston shore have become less effective in holding sand beaches. This has been the case particularly south of the Northwestern University lakefill. Quarrystone revetments now line much of this section of lakeshore.

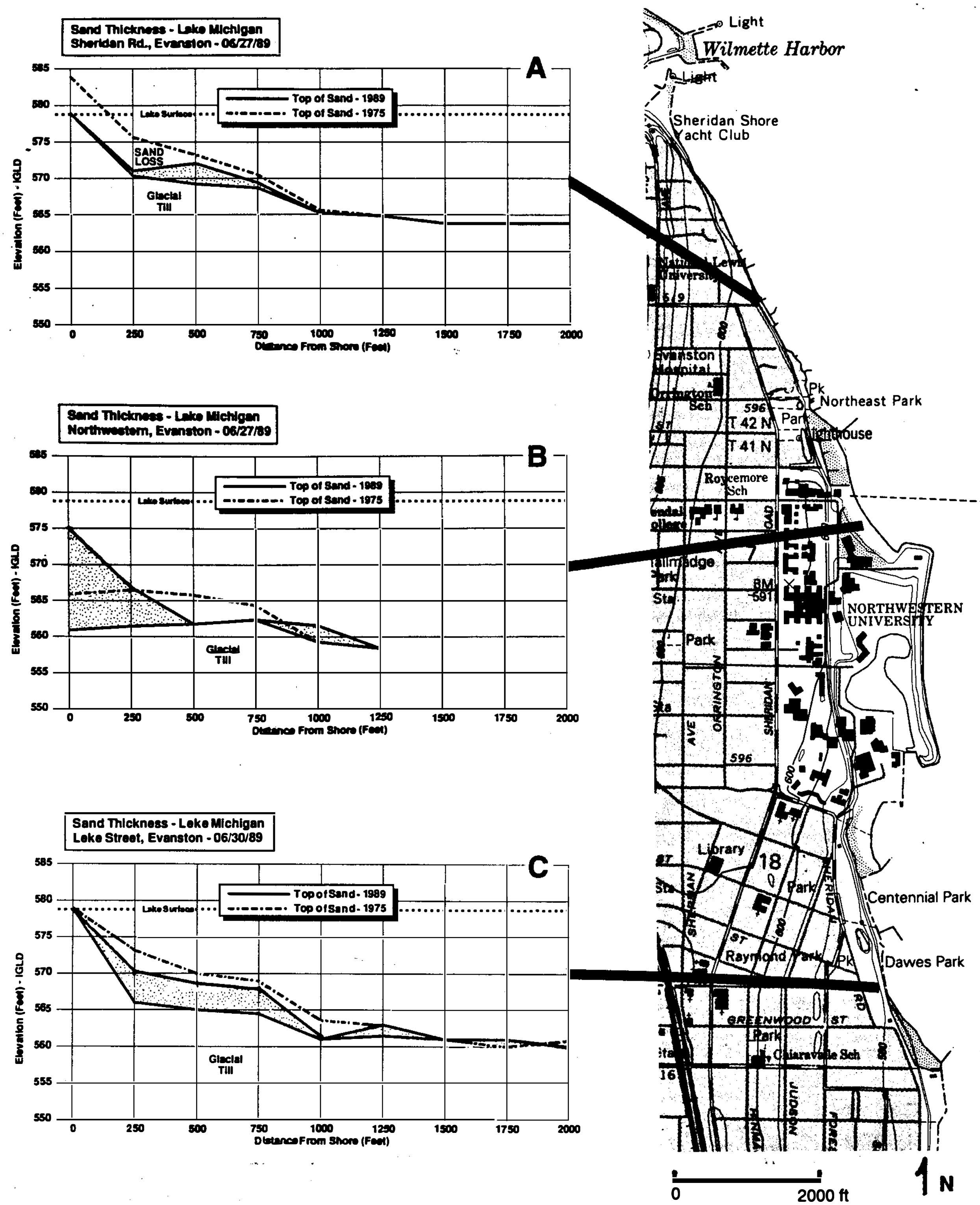

Figure 23. Profile changes along the Evanston near shore between 1975 and 1989. Net accretion occurred on the updrift (north) side of the Northwestern University lakefill (B). Net erosion occurred both a short distance updrift (north) of the lakefill (A) as well as downdrift (C) (from Shabica *et al.* 1991).

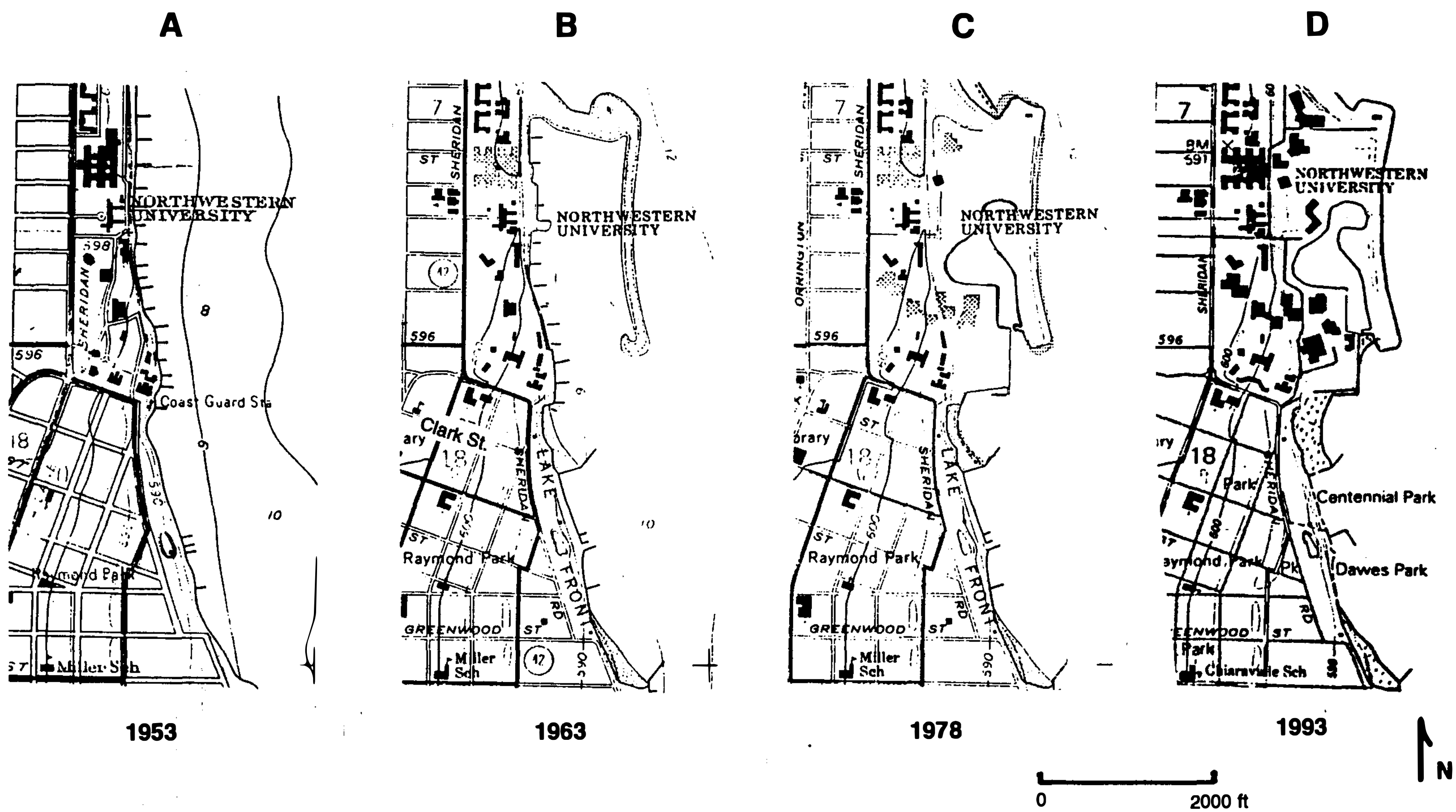

Figure 24. Evanston coastline showing construction and effects of the Northwestern University lakefill. **A) 1953:** groins protect the shore. **B) 1963:** a breakwater has been constructed at Northwestern University and a 600-ft long groin is built at Clark Street beach. **C) 1978:** the lakefill is completed and sand fillets have developed both updrift (north) and downdrift (south) of the lakefill. **D) 1993:** continued accretion has occurred updrift and downdrift of the lakefill; the lagoon and harbor are now blocked by sand (from USGS 1:24,000-scale Evanston Quadrangle; 1953, 1963, 1978 and 1993).

Coastal Management Issues

Lakefront Park Improvements:

The City of Evanston is presently considering options for improving the recreational and aesthetic qualities of its lakefront parks. Two important issues are lowering the crest elevation of the riprap revetment that protects coastal parkland, and reducing the maintenance costs for retaining desired water depths in the Church Street boat-launch basin.

The present crest elevation of the park's revetment is typically 3 ft higher than the park surface elevation. This revetment height prevents park users from viewing the lake. An evaluation will be done to determine what reduced height would still provide adequate protection from wave runup and overwash.

The Church Street boat-launch facility has existed since 1958. In 1982, to improve wave protection at the boat launch, the facility was partially enclosed by a breakwater on the north and east sides. This structure consists of a stone-filled steel bin faced with 3- to 5-ton riprap on the lakeward sides. The south side of the boat-launch basin is protected by a permeable groin constructed of modular concrete.

The boat-launch basin requires annual maintenance dredging to maintain desired depths. Annual dredging is approximately 10,000 cubic yards. This material is disposed of in the nearshore downdrift (south) of the basin. Some of the sand that accumulates in the basin may be derived from the south and moved into the basin by short-lived drift reversals. The primary source is likely sand coming from the north as part of the natural bypass of the Northwestern University lakefill.

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Breakwater Protected Harbor

NORTH POINT MARINA

Slip Sizes and Power Available at Docks

Recreational Basin

Dock	Size (length x width)	Power
A	60' x 19'	single 50 amp/208 volt
A	55' x 18.5'	single 50 amp/208 volt
B	50' x 17.5'	single 50 amp/208 volt
C	45' x 17'	single 50 amp/120 volt
D	40' x 15.5'	single 50 amp/120 volt
E	40' x 15.5'	single 30 amp/120 volt
E(10 slips)	40' x 15.5'	single 50 amp/120 volt
F	40' x 15.5'	single 30 amp.120 volt
G	30' x 13'	single 30 amp/120 volt
H	30' x 13'	single 30 amp/120 volt
I	30' x 13'	single 30 amp/120 volt
J	30' x 13'	single 30 amp/120 volt
K	35' x 15'	single 30 amp/120 volt
L	35' x 15'	single 30 amp/120 volt
M	35' x 15'	single 30 amp/120 volt
N	40' x 15.5'	single 50 amp/120 volt
O	40' x 15.5'	single 50 amp/120 volt
P	45' x 17'	single 50 amp/120 volt

Dock	Size (length x width)	Power
Q	45' x 17.5'	single 50 amp/120 volt
Q	50' x 17.5'	single 50 amp/208 volt
R	55' x 17.5'	single 50 amp/208 volt
A	End-Tie 68'	dual 50 amp/208 volt
B	End-Tie 108'	dual 50 amp/208 volt
C	End-Tie P	pumpout facility
D	End-Tie P	pumpout facility
E	End-Tie 88'	dual 50 amp/208 volt
F	End-Tie 88'	dual 50 amp/208 volt
J	End-Tie 68'	dual 50 amp/208 volt
K	End-Tie 78'	dual 50 amp/208 volt
L	End-Tie 78'	dual 50 amp/208 volt
M	End-Tie 78'	dual 50 amp/208 volt
N	End-Tie 88'	dual 50 amp/208 volt
O	End-Tie 88'	dual 50 amp/208 volt
P	End-Tie 98'	dual 50 amp/208 volt
Q	End-Tie 103'	dual 50 amp/208 volt
R	End-Tie 63'	dual 50 amp/208 volt

Commercial Basin

Dock	Size (length x width)	Power
AA	30' x 13'	single 30 amp/120 volt
AA	35/40'x 15.5'& 16.5'	single 50 amp/120 volt
AB	35/40'x15.5'	single 30 amp/120 volt
AC	40/45'x17'	single 30 amp/120 volt

Dock	Size (length)	Power
AA	End-Tie 57'	single 30 amp/120 volt
AA	End-Tie	single 50 amp/208 volt
AB	End-Tie 83'	dual 50 amp/208 volt
AC	End-Tie F.D.	dual 50 amp/208 volt

Details are also available at the marina office.

Call North Point Marina, 847.746.2845

NORTH POINT MARINA

SAME RATES FOR '96

A WORLD CLASS MARINA AT A WORLD CLASS BARGAIN ! !

1996 Rates and Discounts

All slips retain reduced 1995 annual rates

30 foot slip – $1,470
35 foot slip – $1,715
40 foot slip – $1,960
45 foot slip – $2,430

(Over 60 foot rates vary, call for a cost estimate)

50 foot slip – $2,850
55 foot slip – $3,245
60 foot slip – $3,540

(Up to 3 feet of overhang is allowed at $60 per foot)

Slip Discounts

LONGEVITY DISCOUNT

3% DISCOUNT . . . for slipholders whose 1996 rentals represent third, fourth or fifth consecutive full season rentals.

5% DISCOUNT . . . is available for the sixth or more consecutive full season rentals.

OLD SALT CLUB

ONE FREE UPGRADE to the next larger slip . . . for slipholders in their seventh consecutive full year.

EARLY PAYMENT DISCOUNT

3% DISCOUNT . . . when you pay your 1996 annual fee in full by January 10, 1996.

5% DISCOUNT . . . when you pay your 1996 annual fee in full by November 15, 1996.

SECOND SLIP DISCOUNT

60% DISCOUNT off of the 1996 full season charge . . . for permanent slipholders leasing a second slip on their dock 40 feet or larger.

Details of these discount programs are available at the marina office. As an added convenience, credit card payments for slip fees are allowed subject to a service charge.

Call North Point Marina, 847.746.2845